PATENT ABSTRACTS OF JAPAN

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(22)Date of filing : 25.06.1999 (72)Inventor : TSUZUKI TAKEO

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(54) ULTRASONIC WAVE SENSOR

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a ultrasonic wave sensor where the directivity, that is, a radiation spread angle can be made narrow in spite of a simple configuration.

SOLUTION: The ultrasonic wave sensor is provided with a cylinder section (support cylinder section) 22 of a cylindrical case 2 whose bottom 21 is formed in

a diaphragm and on which an ultrasonic wave vibrator 1 is fixed and with an interposition member 4 that is placed between an outer frame 3 and the case 2 to absorb vibration energy. The interposition member 4 has a groove 42 that is close to a circumferential edge of the diaphragm 21 and not closely adhered to the support cylinder 2 of the cylindrical case 2. The groove 42 of this interposition member 4 may be provided over the entire circumference or provided over a prescribed angular range in the circumferential direction. In the case of providing the groove 42 of the interposition member 4 over the entire circumference of the diaphragm 21, the directivity of an ultrasonic wave energy emitted from the sensor, that is, a radiation spread angle can be made narrow, and in the case of providing the groove 42 of the interposition member 4 over a prescribed angular range in the circumferential direction of the diaphragm 21, the directivity of the ultrasonic wave energy emitted from the sensor, that is, the radiation spread angle can be made narrow at a side at which the groove 42 is provided.

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examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]

[Claim 1] The tubed case where it has the bottom surface part which makes a diaphragm, and the tubed support cylinder part which protrudes towards one side from the periphery of said bottom surface part, The ultrasonic vibrator of the shape of sheet metal which it is fixed [shape] to the principal plane of said one side of said diaphragm, and vibrates said diaphragm in the thickness direction, The outside frame prepared by separating predetermined spacing to said support cylinder part of said tubed case, And said support cylinder part is supported, bearing being carried out to said frame, while being interposed between said outside frames and peripheral faces of the support cylinder part of said ultrasonic sensor. And it is the ultrasonic sensor which is equipped with the interposition member which attenuates the vibrational energy of said support cylinder part, and is characterized by having the slot which said interposition member approaches the periphery of said diaphragm, and is not stuck to said support cylinder part.

[Claim 2] It is the ultrasonic sensor characterized by having the slot which is not

stuck to a part of predetermined hoop direction of said support cylinder part where said interposition member adjoins the periphery of said diaphragm in an ultrasonic sensor according to claim 1, and not having said slot in said slot and hoop direction opposite side.

[Claim 3] It is the ultrasonic sensor which is used for the obstruction sensor for cars which detects the reflected wave by the obstruction, and is characterized by for said slot of said interposition member adjoining the lower part of said support cylinder part which adjoins the margo-inferior section of said diaphragm, and arranging it by being fixed to the side face of a car, receiving horizontally from said car in an ultrasonic sensor according to claim 2, having whenever [vertical predetermined angle-of-divergence], and emitting a supersonic wave.

[Claim 4] The tubed case where it has the bottom surface part which makes a diaphragm, and the tubed support cylinder part which protrudes towards one side from the periphery of said bottom surface part, The ultrasonic vibrator of the shape of sheet metal which it is fixed [shape] to the principal plane of said one side of said diaphragm, and vibrates said diaphragm in the thickness direction, The outside frame prepared by separating predetermined spacing to said support cylinder part of said tubed case, And said support cylinder part is supported, bearing being carried out to said frame, while being interposed between said outside frames and peripheral faces of the support cylinder part of said ultrasonic sensor. And the part which it has the interposition member which attenuates the vibrational energy of said support cylinder part, and said interposition member approaches the periphery of said diaphragm, and is stuck to said support cylinder part is an ultrasonic sensor characterized by restraining said support cylinder part weakly rather than other parts.

[Claim 5] It is the ultrasonic sensor characterized by having the low restricted field which approaches set to an ultrasonic sensor according to claim 4, and predetermined [of the periphery of said diaphragm / a part of] in said interposition member, and restrains said support cylinder part weakly, and the high restricted field which approaches the remainder of the periphery of said

diaphragm and restrains said support cylinder part strongly.

[Claim 6] It is the ultrasonic sensor which is used for the obstruction sensor for cars which detects the reflected wave by the obstruction , and is characterized by for said low restricted field of said interposition member adjoining the lower part of said support cylinder part which adjoins the margo inferior section of said diaphragm , and arranging it by being fixed to the side face of a car , receiving horizontally from said car in an ultrasonic sensor according to claim 5 , having whenever [vertical predetermined angle of divergence] , and emitting a supersonic wave .

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to an ultrasonic sensor applicable to the obstruction detection sensor for cars suitably about an ultrasonic sensor.

[0002]

[Description of the Prior Art] A supersonic wave is transmitted from car back or a corner with the ultrasonic sensor formed in the bumper of a car, and he receives

the supersonic wave reflected with the obstruction, and is trying to detect the obstruction with the conventional obstruction detection equipment for cars.

[0003] Drawing An example of the ultrasonic sensor used as conventional obstruction detection equipment for cars is shown.

[0004] the ultrasonic vibrator with which 1 comes to prepare an electrode in both the principal planes of a porcelain piezo-electricity plate made from PZT etc., respectively, the tubed case where, as for 2, an ultrasonic vibrator 1 is fixed, and 3 -- a collar -- a with cylindrical shape-like outside frame and 40 are the interposition members prepared between the outside frame 3 and the tubed case 2, and the outside frame 3 has fitted into the hole of the bumper which is not illustrated.

[0005] The tubed case 2 consists of a closed-end cylindrical shape-like metal can, and the bottom surface part 21 of this tubed case 2 emits a supersonic wave as a diaphragm, and detects a reflected wave. An ultrasonic vibrator 1 is fixed to the bottom surface part of a background of the tubed case 2, i.e., the center of a diaphragm 21, alternating voltage is impressed between the two electrodes of an ultrasonic vibrator 1, and a diaphragm 21 is vibrated.

[0006] Bearing of the cylinder part (it is also called a support cylinder part) 22 of the tubed case 2 is carried out by the outside frame 3 through the interposition member 40 which consists of a both-ends opening cylindrical shape-like rubber object for vibration deadening. That is, this diaphragm 21 uses as a knot the periphery of the diaphragm 21 which adjoins that cylinder part (support cylinder part) 22, and vibrates considering the direction core of a path of a diaphragm 21 as an antinode, and the interposition member 40 inhibits that vibration of a diaphragm 21 is transmitted to an external bumper through the outside frame 3.

[0007]

[Problem(s) to be Solved by the Invention] In the above-mentioned ultrasonic sensor, since there was fault incorrect-detected with the reflected wave from an obstruction by the reflected wave by road surface irregularity when whenever [directional-characteristics / of the vertical direction /, i.e., radiation angle of

divergence,] is large, whenever [to the vertical direction, especially the bottom / directional-characteristics, i.e., radiation angle of divergence,] needed to be narrowed. Although whenever [directional-characteristics, i.e., radiation angle of divergence,] could be narrowed by raising a frequency, there was a request of wanting to realize **-ization of whenever [directional-characteristics, i.e., radiation angle of divergence], without changing a frequency rather than to to be free to frequency selection at slag with other conditions.

[0008] this invention is made in view of the above-mentioned trouble -- having -- a simple configuration -- whenever [directional-characteristics, i.e., radiation angle of divergence,] -- ** -- it sets it as the purpose to offer the ultrasonic sensor [-izing / an ultrasonic sensor].

[0009] Moreover, in the ultrasonic sensor used as conventional obstruction detection equipment for cars mentioned above, in order to reduce the reflected wave a setup of whenever [directional-characteristics / of the right-and-left upper and lower sides /, i.e., radiation angle of divergence,] is important, and according especially to road surface irregularity to shaft orientations (the oscillating direction), to make small whenever [to a lower part / directional-characteristics, i.e., radiation angle of divergence,] was desired.

[0010] When it did in this way although only the horizontal more nearly required include angle could rotate shaft orientations (the oscillating direction) upward in order to have solved this problem, there was a problem that the diaphragm 21 which makes the acoustic emission side of an ultrasonic sensor became depressed outside from the outside surface of a bumper 1 at a protrusion or back side, and spoiled a fine sight.

[0011] This invention is made in view of the above-mentioned trouble, and it is a simple configuration, and sets it as the purpose to offer the ultrasonic sensor which whenever [over the shaft orientations (the oscillating direction) which intersect perpendicularly with the principal plane of a diaphragm / directional-characteristics, i.e., radiation angle of divergence,] can narrow alternatively only in the hoop direction predetermined part of a diaphragm.

[0012]

[Means for Solving the Problem] In the ultrasonic sensor according to claim 1 which attains the above-mentioned purpose, the peripheral face of the cylinder part (support cylinder part) of the tubed case where a bottom surface part makes a diaphragm and an ultrasonic vibrator is fixed is supported by the inner skin of the outside frame for support through the interposition member which has a vibrational-energy absorption function. Especially with this configuration, it has the slot which an interposition member approaches the periphery of a diaphragm and does not stick to the support cylinder part of a tubed case. The slot of this interposition member may be prepared over the perimeter of a diaphragm, and may prepare only the predetermined include-angle range of a hoop direction.

[0013] According to the experiment, when the slot of an interposition member was prepared over the perimeter of a diaphragm, it turned out that whenever [directional-characteristics / of the ultrasonic energy emitted from a sensor /, i.e., radiation angle of divergence,] can be narrowed.

[0014] A configuration according to claim 2 is further prepared for a slot only in the part close to the part of the predetermined include-angle range of the periphery of a diaphragm in an ultrasonic sensor according to claim 1. According to the experiment, by doing in this way showed that whenever [to the side which has a slot / directional-characteristics, i.e., radiation angle of divergence,] could be narrowed.

[0015] According to the configuration according to claim 3, in an ultrasonic sensor according to claim 2, this ultrasonic sensor is further used as an obstruction sensor for cars, and the slot of an interposition member adjoins the lower part of the support cylinder part which adjoins the margo-inferior section of a diaphragm, and is arranged.

[0016] According to the ultrasonic sensor according to claim 4 which attains the above-mentioned purpose, the part which approaches the periphery of a diaphragm among the interposition members interposed between the cylinder part (support cylinder part) of the tubed case where a bottom surface part makes

a diaphragm and an ultrasonic vibrator is fixed, and the outer flame, and is stuck to a support cylinder part is characterized by being the low restricted field which restrains said support cylinder part weakly rather than other parts. This low restricted field may be prepared over the perimeter of a diaphragm, and may be prepared covering a predetermined include angle.

[0017] According to the experiment, whenever [directional-characteristics / of the ultrasonic energy emitted from a sensor when preparing the low restricted field of an interposition member over the perimeter of a diaphragm /, i.e., radiation angle of divergence,] can be narrowed. Moreover, when only the predetermined include-angle range of the hoop direction of a diaphragm prepared the low restricted field of an interposition member, it turned out that whenever [directional-characteristics / of the ultrasonic energy emitted from a sensor /, i.e., radiation angle of divergence,] can be narrowed in the side in which the low restricted field was established.

[0018] According to the configuration according to claim 5, in an ultrasonic sensor according to claim 4, this ultrasonic sensor is further used as an obstruction sensor for cars, and the low restricted field of an interposition member adjoins the lower part of the support cylinder part which adjoins the margo-inferior section of a diaphragm, and is arranged.

[0019]

[Embodiment of the Invention] Hereafter, the operation gestalt which shows this invention in drawing is explained.

[0020] With reference to ** type drawing of longitudinal section showing 1 operation gestalt of the ultrasonic sensor of this invention used as the sensor section of the obstruction detection equipment for cars in drawing 1 , it explains below.

[0021] the ultrasonic vibrator with which 1 comes to prepare an electrode in both the principal planes of a porcelain piezo-electricity plate made from PZT etc., respectively, the tubed case where, as for 2, an ultrasonic vibrator 1 is fixed, and 3 -- a collar -- a with cylindrical shape-like outside frame and 4 are the

interposition members prepared between the outside frame 3 and the tubed case 2, and the cylinder part 30 of the outside frame 3 has fitted into the hole of the bumper which is not illustrated.

[0022] The tubed case 2 consists of a closed-end cylindrical shape-like metal can, and the bottom surface part 21 of this tubed case 2 emits a supersonic wave as a diaphragm, and detects a reflected wave. An ultrasonic vibrator 1 is fixed to the bottom surface part of a background of the tubed case 2, i.e., the center of a diaphragm 21, alternating voltage is impressed between the two electrodes of an ultrasonic vibrator 1, and a diaphragm 21 is vibrated.

[0023] Bearing of the cylinder part (it is also called a support cylinder part) 22 of the tubed case 2 is carried out by the outside frame 3 through the interposition member 4 which consists of a both-ends opening cylindrical shape-like rubber object for vibration deadening. That is, this diaphragm 21 uses as a knot the periphery of the diaphragm 21 which adjoins that cylinder part (support cylinder part) 22, and vibrates considering the direction core of a path of a diaphragm 21 as an antinode, vibration of a diaphragm 21 makes vibration of the support cylinder part 22 of the tubed case 2 derive, and vibration of this support cylinder part 22 is transmitted to the bumper which the exterior does not illustrate through the cylinder part 30 of the interposition member 4 and the outside frame 3.

[0024] The interposition member 4 which makes the focus of this example was formed in the shape of [of thickness regularity] a cylindrical shape according to the gap of the shape of a cylinder between the inner skin of the support cylinder part 22 of the tubed case 2, and the cylinder part 30 of the outside frame 3, stuck the inner skin of the interposition member 4 to the peripheral face of the support cylinder part 22, and has stuck the peripheral face of the interposition member 4 to the inner skin of the outside frame 3. Even if the diaphragm 21 of the tubed case 2 vibrates by crookedness vibration of an ultrasonic vibrator 1 and the support cylinder part 22 of the tubed case 2 accompanies and vibrates by that cause by this, the vibrational energy of the support cylinder part 22 is decreased by the interposition member 4, and vibration of the cylinder part of the outside

frame 3 is inhibited. It is the same as before by forming an ultrasonic vibrator 1 in a rectangle to have set [in / in a longitudinal direction, it is large and / the vertical direction] up narrowly the directional characteristics over the oscillating direction of a diaphragm 21. The upper half of the principal plane 211 of the bottom surface part of the tubed case 2, i.e., the outside of a diaphragm 21, and the end face 41 of the outside of the interposition member 4 and the lateral surface 31 of the outside frame 3 make the flat side which extends to an abbreviation perpendicular direction, and are raising the fine sight of a bumper.

[0025] Especially in this example, from the principal plane 211 of the outside of a diaphragm 21, and the lateral surface 31 of the outside frame 3, only the predetermined depth is cut and, thereby, as for the bottom abbreviation one half (correctly the include-angle range of 140 degrees) of the end face 41 of the outside of the interposition member 4, the slot 42 is formed.

[0026] (Deformation mode 1) A deformation mode is shown in drawing 2 .

[0027] In this deformation mode, the slot 42 was formed over the perimeter. When doing in this way, whenever [directional-characteristics, i.e., radiation angle of divergence,] became narrow over the perimeter rather than the case where there is no slot 42 over the perimeter of a diaphragm 21.

[0028] (Deformation mode 1) A deformation mode is shown in drawing 2 .

[0029] In this deformation mode, it established in the bottom in [include-angle] 90 degrees, and the slot 42 was established in the bottom in [include-angle / two] 90 degrees. When doing in this way, it became narrower than the case where there is no fang furrow section whenever [directional-characteristics / of a top and the bottom /, i.e., radiation angle of divergence,].

[0030] (Deformation mode 3) A deformation mode is shown in drawing 3 .

[0031] In this deformation mode, in the example 1, slot 42a adjoins the thin edge wall (low restricted field said by this invention) 43, and the thin light-gage cylinder part (low restricted field said by this invention) 44, and, thereby, this slot 42a has become invisibility from the exterior.

[0032] When doing in this way, the **-ized effectiveness of whenever

[directional-characteristics, i.e., radiation angle of divergence,] fell, but since slot 42a became invisibility, the fine sight improved.

[0033] (Deformation mode 4) A deformation mode is shown in drawing 4 .

[0034] In this deformation mode, the thin light-gage cylinder part (low restricted field said by this invention) 45 which is close to the inner skin of the outside frame 3 instead of the thin light-gage cylinder part (low restricted field said by this invention) 44 close to the peripheral face of the support cylinder part 22 is formed in the deformation mode 3.

[0035] In addition, in drawing 1 , as long as the restraint of the support cylinder part 22 is weak, a slot 42 may be filled up with a thing like elastic putty.

[0036] (Deformation mode 5) A deformation mode is shown in drawing 5 .

[0037] In this deformation mode, in an example 1, electric shielding flange (low restricted field said by this invention) 21a is lengthened so that a slot 42 may be hidden from the part of the periphery bottom of a diaphragm 21. However, only the gap g to which the lower limit of this electric shielding flange 21a does not contact the inner skin of the outside frame 3 by vibration shall be secured.

[0038] If it does in this way, a slot 42 can be invisibility-ized with an easy configuration, and a fine sight will improve.

[0039] (Experimental result) An experimental result is explained hereafter. The experiment conditions are as follows.

[0040] The sample model A shown in drawing 6 and drawing 7 is the thing of the configuration shown in drawing 2 , and has the structure which established the slot 42 in the perimeter of a diaphragm 21. The sample model B shown in drawing 8 and drawing 9 establishes a slot 42 only in the upper and lower sides in the sample model A. The sample model C shown in drawing 10 and drawing 11 establishes a slot 42 only in the bottom in the sample model B. The sample model D shown in drawing 12 and drawing 13 makes the direction width of face of a path of a slot 42 abbreviation one half in the sample model B, and adjoins and establishes a slot 42 in a diaphragm 21 side. As for the sample model E shown in drawing 14 and drawing 15 , only distance J dents the principal plane

211 of the outside of a diaphragm 21 to shaft orientations rather than the lateral surface 31 of the outside frame 3.

[0041] The tubed case 2 of a cylinder-like-object-with-base configuration is formed considering aluminum as a material, it has the crevice of an abbreviation rectangular parallelepiped configuration inside, and the die length of about 0.7mm and the support cylinder part 22 of the pars basilaris ossis occipitalis of the tubed case 2 where the radius of that peripheral face faces 8mm and this crevice, i.e., the thickness of a diaphragm 21, is 9mm.

[0042] The ultrasonic vibrator 1 is being fixed to the pars basilaris ossis occipitalis of the tubed case 2, i.e., the central background of a diaphragm 21, and the oscillation frequency is 40kHz. The thickness of 19mm, therefore the interposition member 4 of the bore of the cylinder part 30 of the outside frame 3 is 1.5mm. Silicone rubber was used as an interposition member 4. The directional characteristics at the time of changing a dimension variously with each [these] sample model are shown in drawing 16 - drawing 29 . In addition, in drawing 16 - drawing 29 R> 9, the direction of large directional characteristics shows the directional characteristics of a longitudinal direction among the directional characteristics of ** and two **, and the narrower one shows the directional characteristics of the vertical direction. The diaphragm 21 mentioned above produces the difference of these directional characteristics according to the shape of a long rectangle perpendicularly. Stand the pole to the location distant from the diaphragm 21 30cm perpendicularly, and made right and left rotate a diaphragm 21, i.e., a sensor, first, and investigated horizontal directional characteristics, next it was made to rotate up and down, and directional characteristics investigated vertical directional characteristics. Of course, the oscillation time amount of vibrator 1 was ended by the time the reflected wave from the pole carried out incidence to vibrator 1.

[0043] Drawing 16 shows the directional characteristics at the time of setting to 0mm depth A of the slot 42 shown in drawing 7 (sample model A).

[0044] Drawing 17 shows the directional characteristics at the time of setting to

1mm the depth of the slot 42 shown in drawing 7 .

[0045] Drawing 18 shows the directional characteristics at the time of setting to 2mm the depth of the slot 42 shown in drawing 7 .

[0046] The comparison with drawing 16 and drawing 17 shows that directional characteristics improve by forming a slot 42 in the sample model A. Moreover, although it is small, the comparison with drawing 17 and drawing 18 shows that directional characteristics get worse on the contrary, when a slot 42 is too deep.

[0047] Drawing 19 shows the directional characteristics at the time of setting to 8mm right-and-left width of face B of the slot 42 shown in drawing 9 (sample model B), and setting depth C to 1.5mm.

[0048] Drawing 20 shows the directional characteristics at the time of setting to 10mm right-and-left width of face B of the slot 42 shown in drawing 9 , and setting depth C to 1mm.

[0049] Drawing 21 shows the directional characteristics at the time of setting to 10mm right-and-left width of face B of the slot 42 shown in drawing 9 , and setting depth C to 1.5mm.

[0050] Drawing 22 shows the directional characteristics at the time of setting to 10mm right-and-left width of face B of the slot 42 shown in drawing 9 , and setting depth C to 2.0mm.

[0051] According to these drawing 17 - drawing 22 , it turns out that directional characteristics are sharp altogether as compared with the slot-less mold shown in drawing 16 .

[0052] Drawing 23 shows the directional characteristics at the time of setting to 10mm right-and-left width of face D of the slot 42 shown in drawing 11 (sample model C), and setting depth E to 1mm.

[0053] Drawing 24 shows the directional characteristics at the time of setting to 10mm right-and-left width of face D of the slot 42 shown in drawing 11 , and setting depth E to 3mm.

[0054] According to drawing 23 , as compared with drawing 20 which forms a slot 42 up and down, it turns out that only upper directional characteristics have

spread. The comparison with drawing 23 and drawing 24 shows that the directional characteristics of breadth and a top are [the way when the depth of a slot 42 is deep / lower directional characteristics] narrow slightly.

[0055] Drawing 25 shows the directional characteristics at the time of setting to 10mm right-and-left width of face F of the slot 42 shown in drawing 13 (sample model D), and setting depth G to 1.5mm. From drawing 25 , by **-izing the direction width of face of a path of a slot 42 shows that the directional characteristics of the vertical direction are narrow especially.

[0056] Drawing 26 shows the directional characteristics at the time of setting [the right-and-left width of face H of the slot 42 shown in drawing 15 (sample model E)] 1.5mm and shaft-orientations depth J of a slot 42 to 0.5mm for the hollow distance I of 10mm and a diaphragm 21.

[0057] Drawing 27 shows the directional characteristics at the time of setting [the right-and-left width of face H of the slot 42 shown in drawing 15] 2mm and shaft-orientations depth J of a slot 42 to 0.5mm for the hollow distance I of 10mm and a diaphragm 21.

[0058] Drawing 28 shows the directional characteristics at the time of setting [the right-and-left width of face H of the slot 42 shown in drawing 15] 2.5mm and shaft-orientations depth J of a slot 42 to 0.5mm for the hollow distance I of 10mm and a diaphragm 21.

[0059] Drawing 29 shows the directional characteristics at the time of setting [the right-and-left width of face H of the slot 42 shown in drawing 15] 3.0mm and shaft-orientations depth J of a slot 42 to 0.5mm for the hollow distance I of 10mm and a diaphragm 21.

[0060] The case where a diaphragm 21 is not hollowed by establishing the hollow distance I from the comparison with drawing 26 and drawing 21 shows that Sharp can do directional characteristics. Moreover, by comparing drawing 26 with drawing 27 - drawing 29 shows that directional characteristics become large on the contrary, when hollow distance I is enlarged too much.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing of longitudinal section showing the example of the ultrasonic sensor of this invention.

[Drawing 2] It is drawing of longitudinal section showing the deformation mode of the ultrasonic sensor of this invention.

[Drawing 3] It is drawing of longitudinal section showing the deformation mode of the ultrasonic sensor of this invention.

[Drawing 4] It is drawing of longitudinal section showing the deformation mode of the ultrasonic sensor of this invention.

[Drawing 5] It is drawing of longitudinal section showing the deformation mode of the ultrasonic sensor of this invention.

[Drawing 6] It is the ** type front view of the sample model A.

[Drawing 7] It is the ** type axial sectional view of the sample model A.

[Drawing 8] It is the ** type front view of the sample model B.

[Drawing 9] It is the ** type axial sectional view of the sample model B.

[Drawing 10] It is the ** type front view of the sample model C.

[Drawing 11] It is the ** type axial sectional view of the sample model C.

[Drawing 12] It is the ** type front view of the sample model D.

[Drawing 13] It is the ** type axial sectional view of the sample model D.

[Drawing 14] It is the ** type front view of the sample model E.

[Drawing 15] It is the ** type axial sectional view of the sample model E.

[Drawing 16] It is drawing showing the directional characteristics of the sample model A.

[Drawing 17] It is drawing showing the directional characteristics of the sample model A.

[Drawing 18] It is drawing showing the directional characteristics of the sample model A.

[Drawing 19] It is drawing showing the directional characteristics of the sample model B.

[Drawing 20] It is drawing showing the directional characteristics of the sample model B.

[Drawing 21] It is drawing showing the directional characteristics of the sample model B.

[Drawing 22] It is drawing showing the directional characteristics of the sample model B.

[Drawing 23] It is drawing showing the directional characteristics of the sample model C.

[Drawing 24] It is drawing showing the directional characteristics of the sample model C.

[Drawing 25] It is drawing showing the directional characteristics of the sample model D.

[Drawing 26] It is drawing showing the directional characteristics of the sample model E.

[Drawing 27] It is drawing showing the directional characteristics of the sample model E.

[Drawing 28] It is drawing showing the directional characteristics of the sample model E.

[Drawing 29] It is drawing showing the directional characteristics of the sample

model E.

[Description of Notations]

1 -- Ultrasonic vibrator

2 -- Tubed case

3 is an outside frame.

4 is an interposition member.

21 is a diaphragm.

42 is a slot.

44 -- Light-gage cylinder part (low restricted field said by this invention)

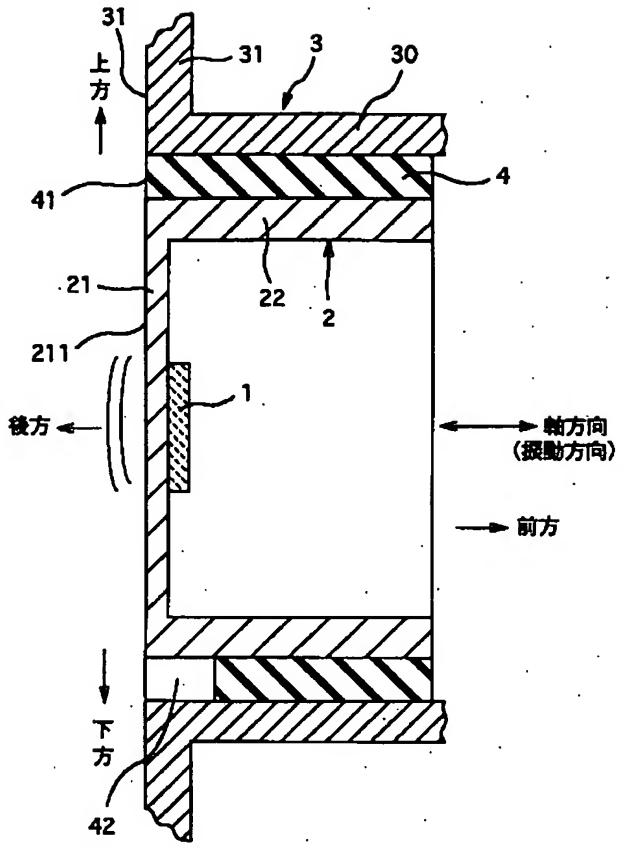
45 -- Light-gage cylinder part (low restricted field said by this invention)

[Translation done.]

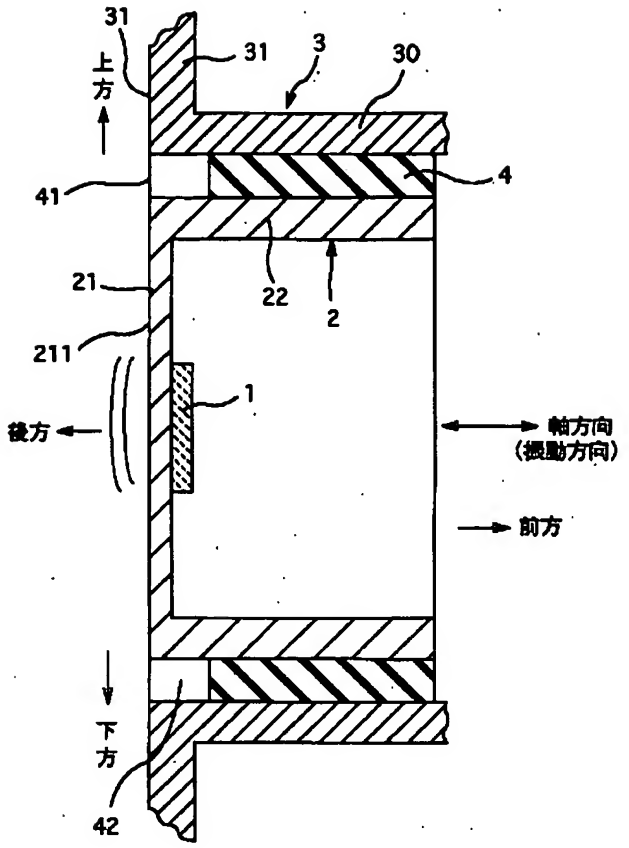
* NOTICES *

DRAWINGS

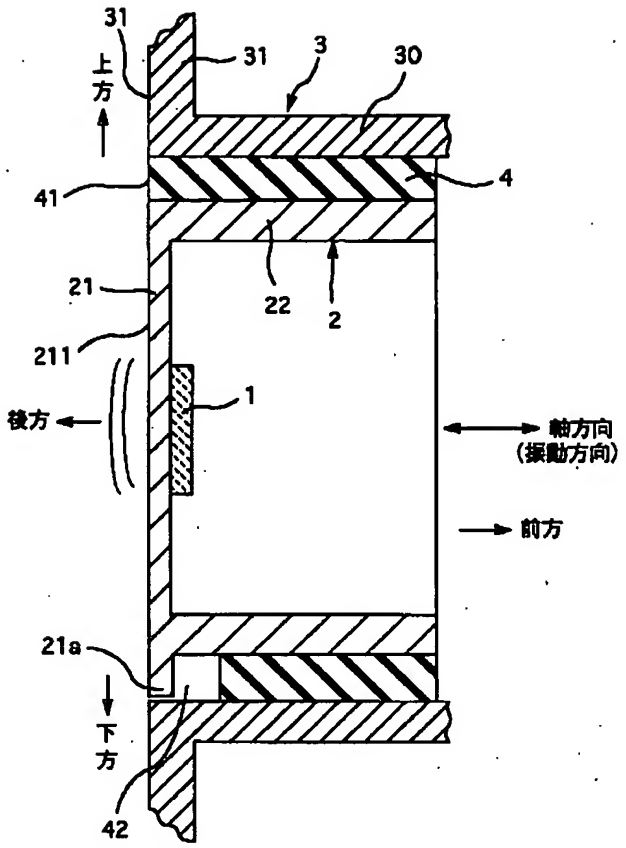
[Drawing 1]



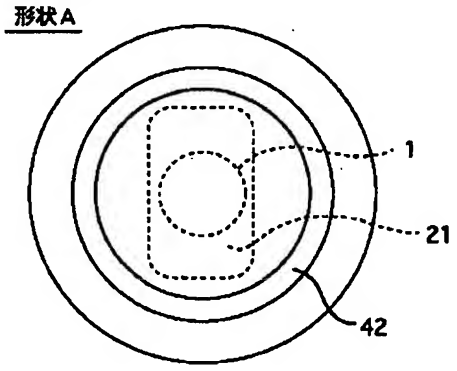
[Drawing 2]



[Drawing 5]



[Drawing 6]



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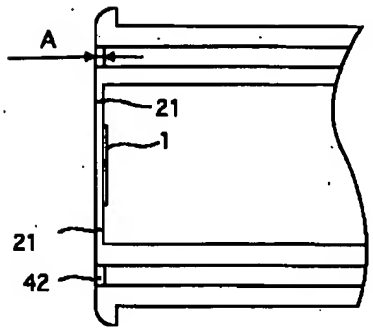
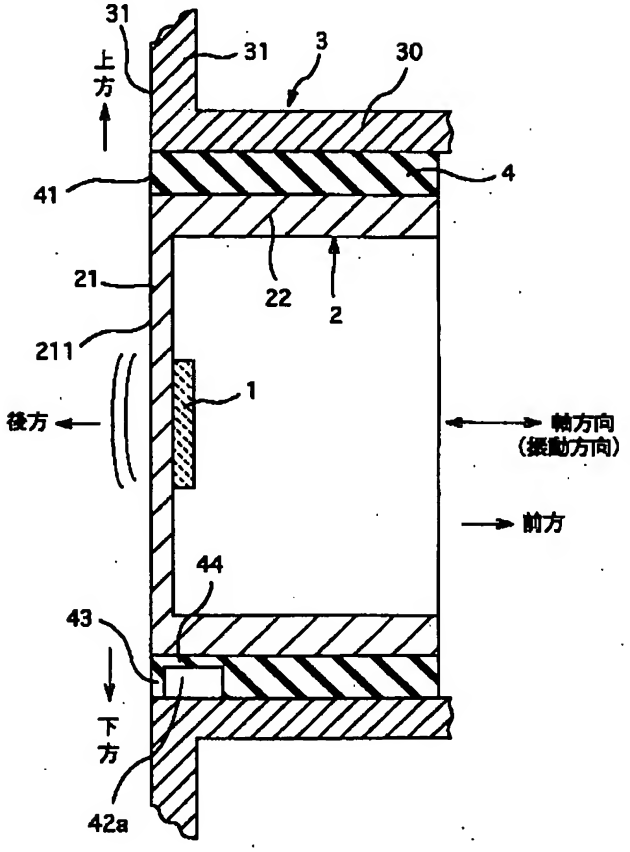
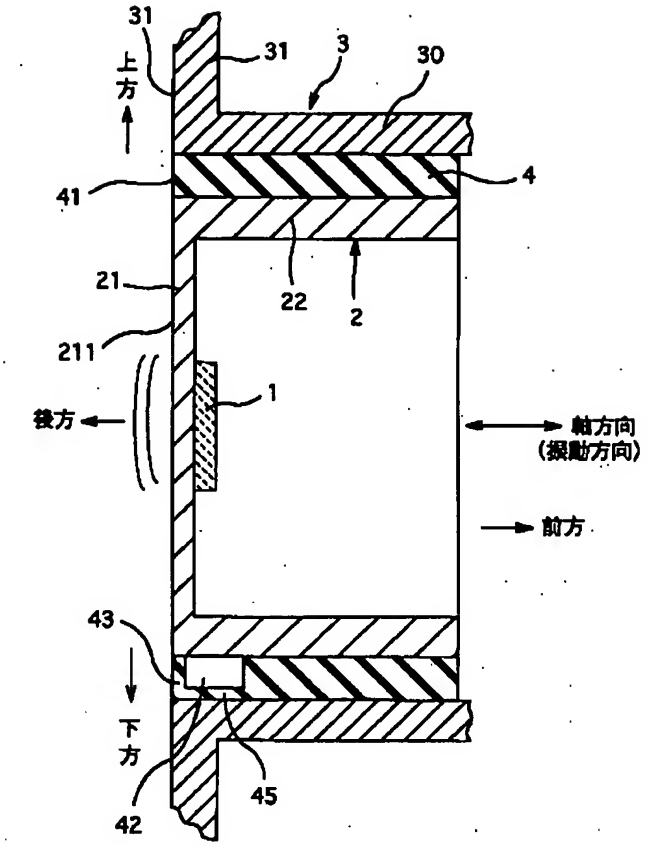


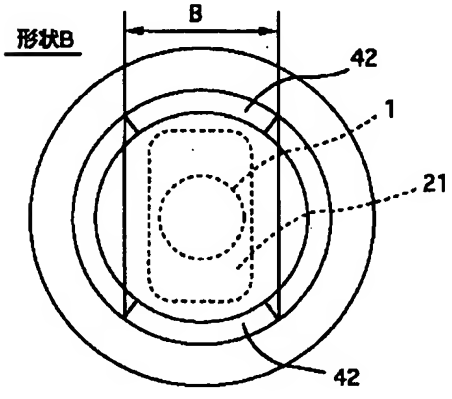
[Drawing 3]



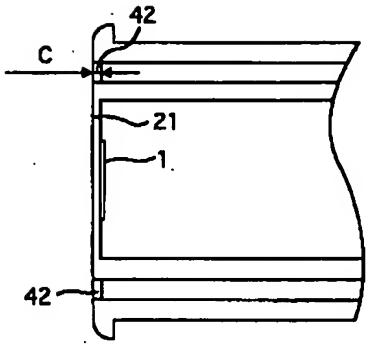
[Drawing 4]



[Drawing 8]



[Drawing 9]



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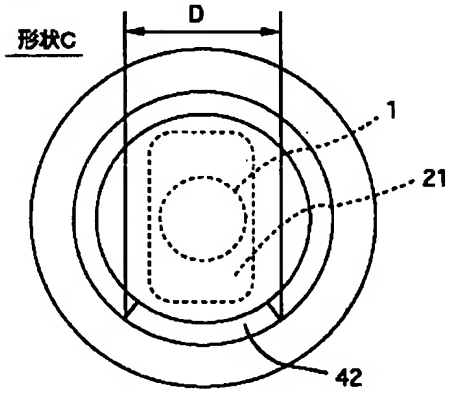

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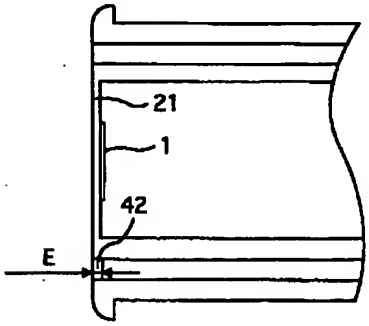

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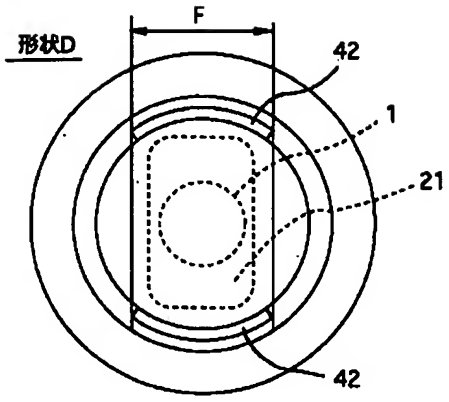

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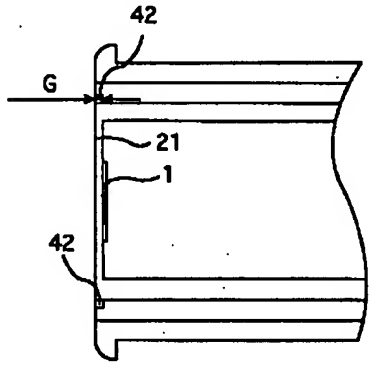

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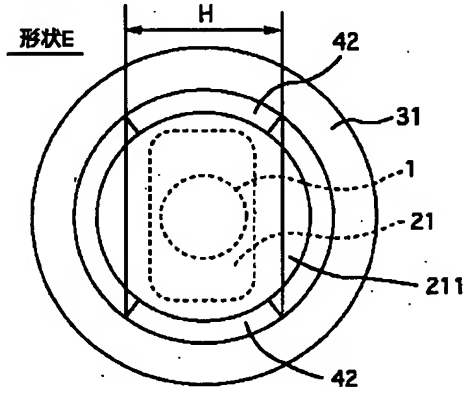

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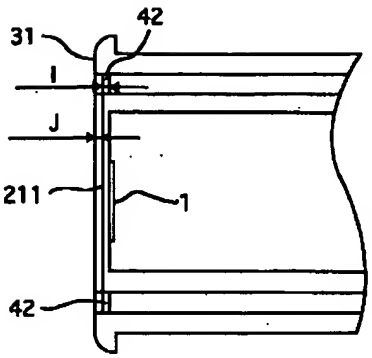

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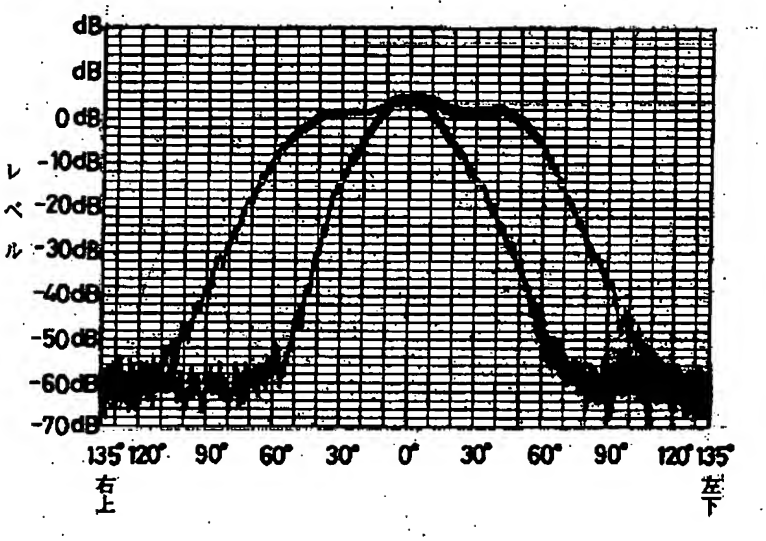

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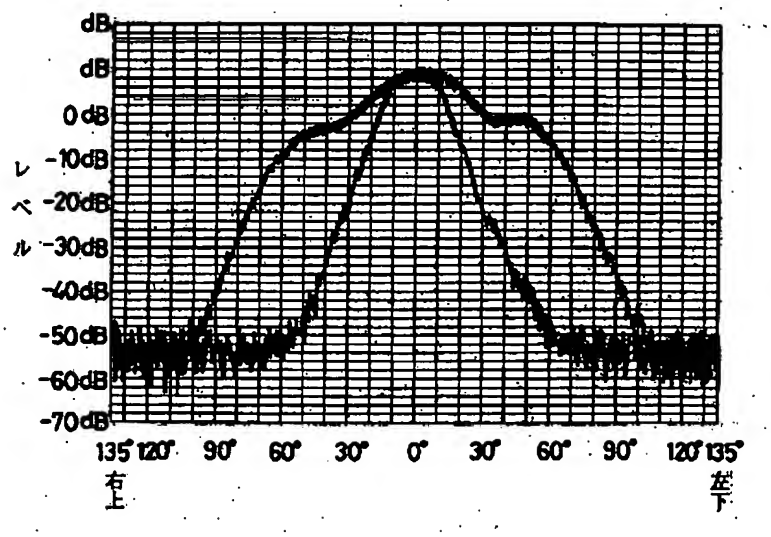

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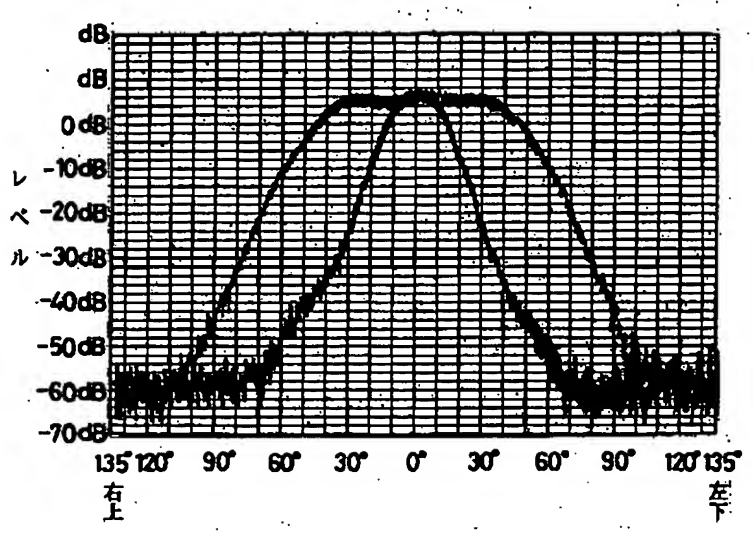

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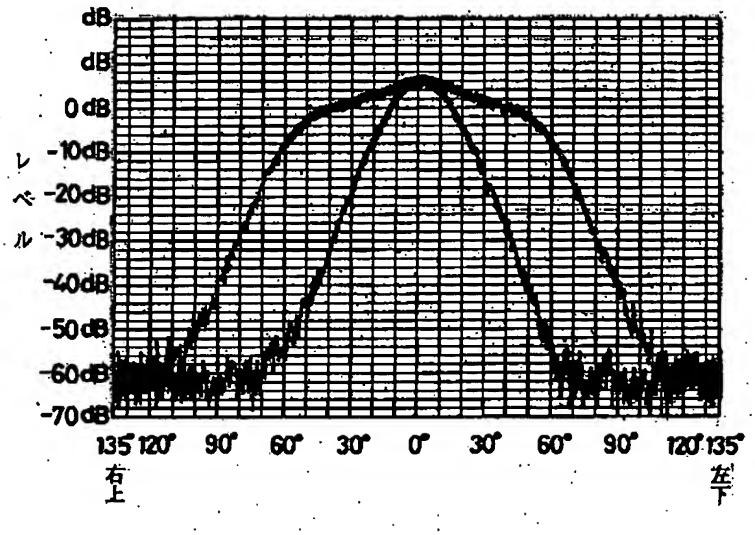

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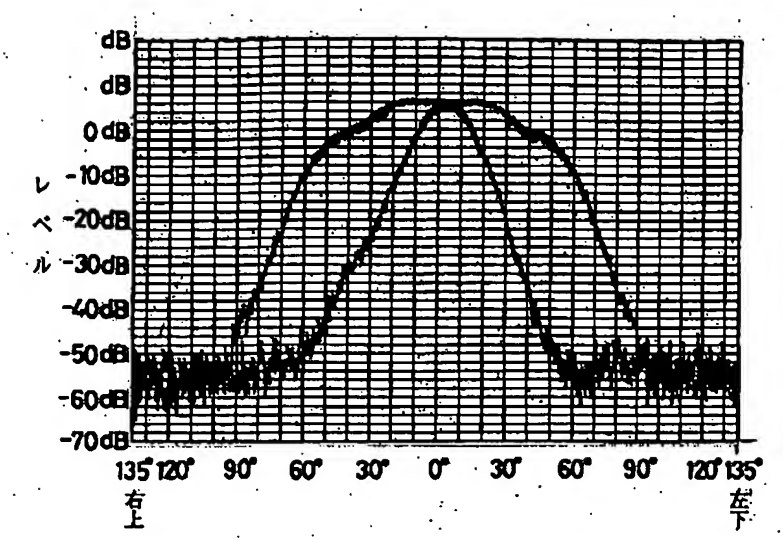

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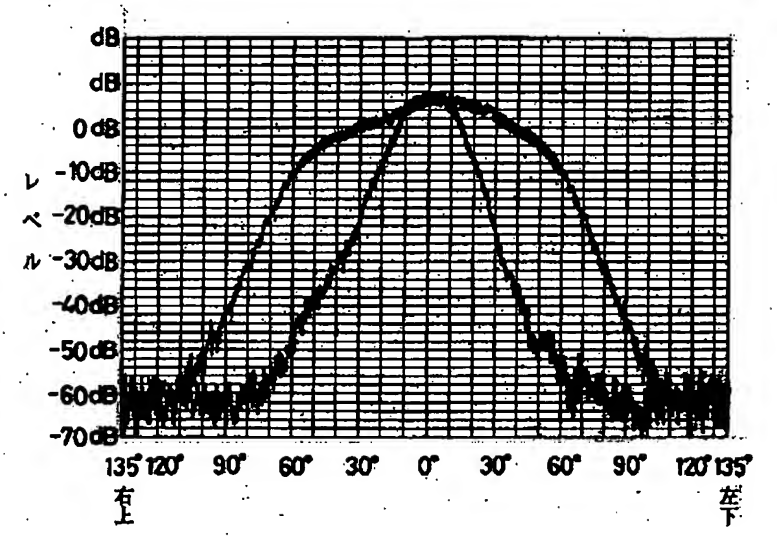

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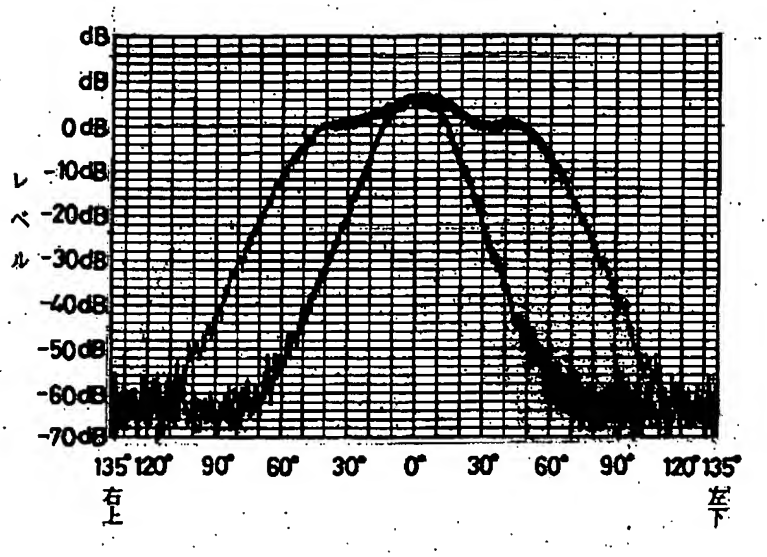

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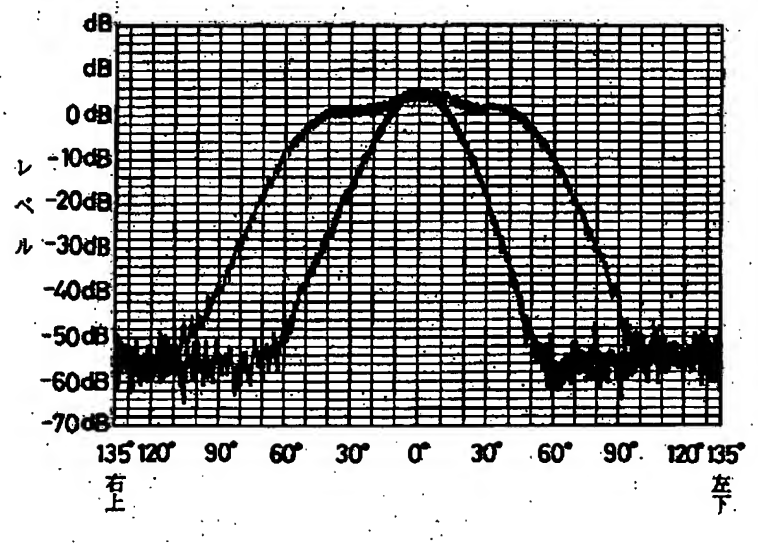

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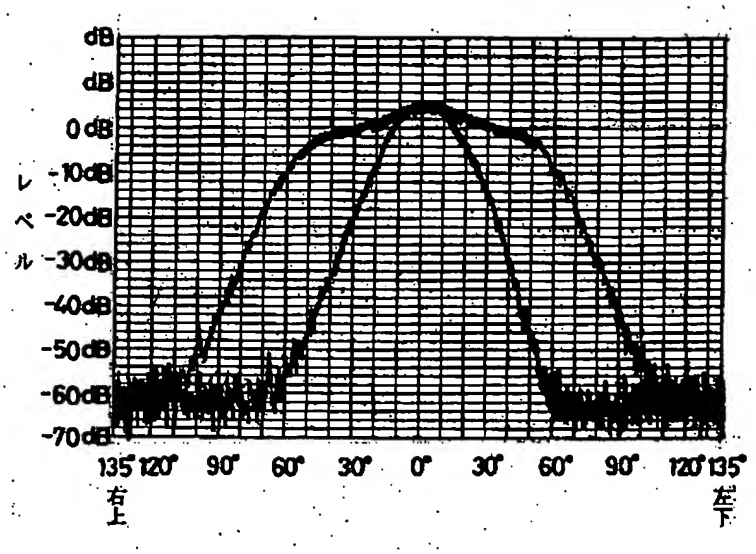

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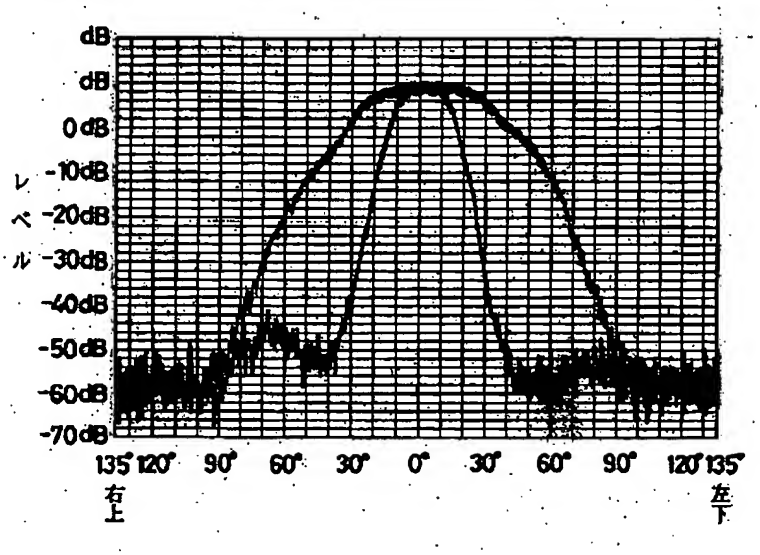

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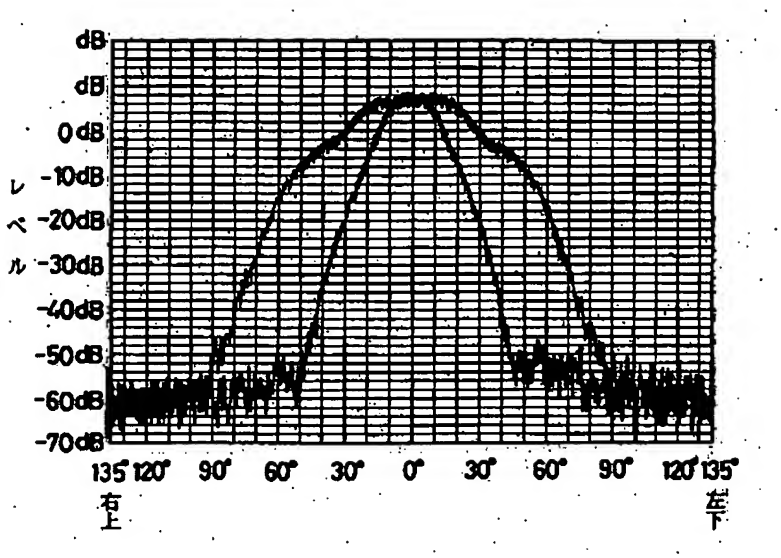

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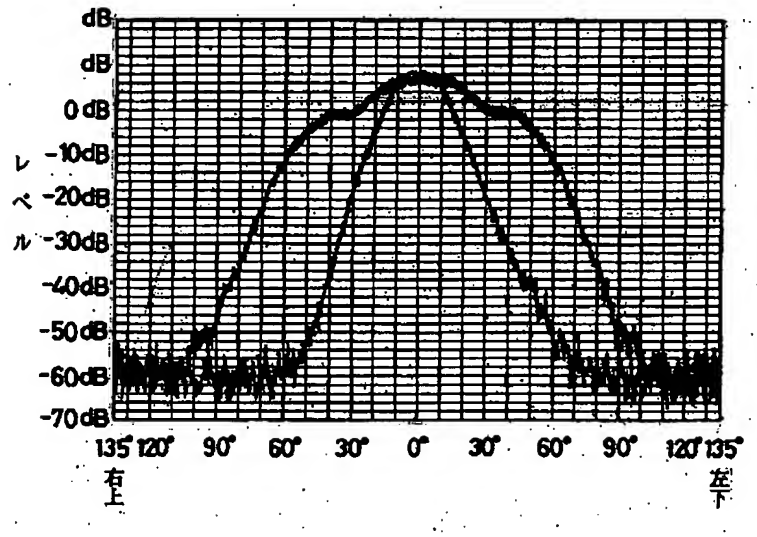

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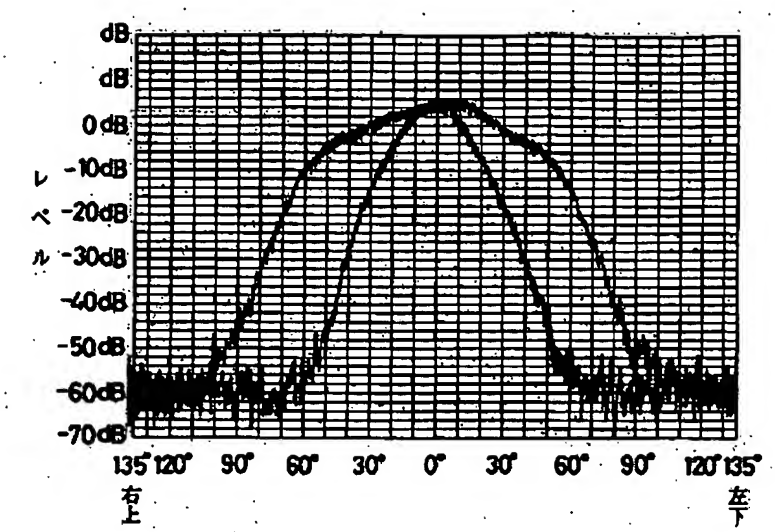

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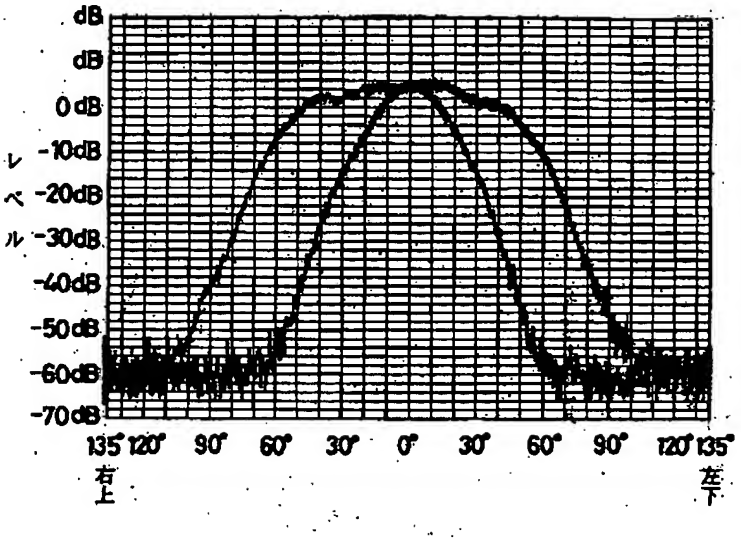

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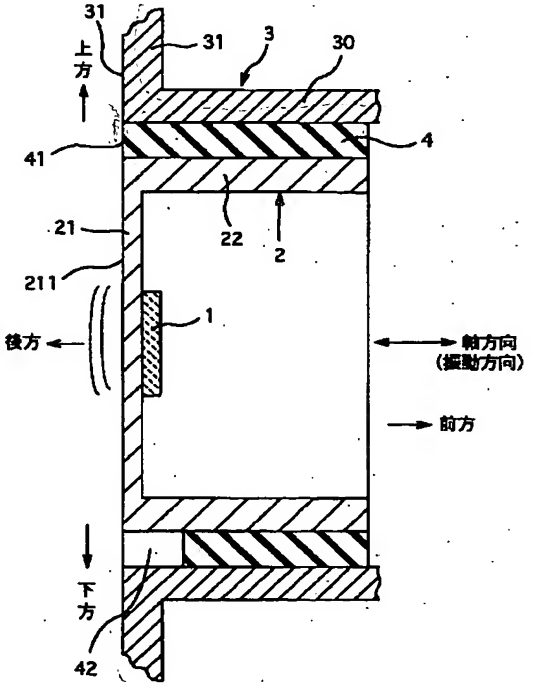
(54)【発明の名称】超音波センサ

(57)【要約】

【課題】簡素な構成で指向特性すなわち放射広がり角度を狭化可能な超音波センサを提供する。

【解決手段】底面部２１が振動板をなして超音波振動子１が固定される筒状ケース２の筒部（支持筒部）２２と、外側フレーム３との間に振動エネルギーを吸収する介設部材４が設けられる。介設部材４は、振動板２１の周縁に近接して筒状ケース２の支持筒部２に密着しない溝部４２を有する。この介設部材４の溝部４２は、振動板２１の全周にわたって設けてもよく、周方向の所定角度範囲だけ設けてもよい。介設部材４の溝部４２を振動板２１の全周にわたって設ける場合にはセンサから放射される超音波エネルギーの指向特性すなわち放射広がり角度を狭くすることができ、また、介設部材４の溝部４２を振動板２１の周方向の所定角度範囲だけ設ける場合にはセンサから放射される超音波エネルギーの指向特性すなわち放射広がり角度を溝部４２を設けたサイドにおいて狭くすることができる。



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【特許請求の範囲】

【請求項１】振動板をなす底面部、及び、前記底面部の周縁から一方側へ向けて突設される筒状の支持筒部を有する筒状ケース、

前記振動板の前記一方側の主面に固定されて前記振動板をその厚さ方向へ振動させる薄板状の超音波振動子、

前記筒状ケースの前記支持筒部に対して所定間隔を隔てて設けられる外側フレーム、及び、

前記外側フレームと前記超音波センサの支持筒部の外周面との間に介設されるとともに前記フレームに支承されつつ前記支持筒部を支承し、かつ、前記支持筒部の振動エネルギーを減衰させる介設部材を備え、

前記介設部材は、前記振動板の周縁に近接して前記支持筒部に密着しない溝部を有することを特徴とする超音波センサ。

【請求項２】請求項１記載の超音波センサにおいて、

前記介設部材は、前記振動板の周縁に隣接する前記支持筒部の周方向の所定の一部に密着しない溝部を有し、前記溝部と周方向反対側にて前記溝部を持たないことを特徴とする超音波センサ。

【請求項３】請求項２記載の超音波センサにおいて、

車両の側面に固定されて前記車両から水平方向に対して上下所定の広がり角度を有して超音波を放射することにより障害物による反射波を検出する車両用障害物センサに用いられ、

前記介設部材の前記溝部は、前記振動板の下縁部に隣接する前記支持筒部の下部に隣接して配置されることを特徴とする超音波センサ。

【請求項４】振動板をなす底面部、及び、前記底面部の周縁から一方側へ向けて突設される筒状の支持筒部を有する筒状ケース、

前記振動板の前記一方側の主面に固定されて前記振動板をその厚さ方向へ振動させる薄板状の超音波振動子、

前記筒状ケースの前記支持筒部に対して所定間隔を隔てて設けられる外側フレーム、及び、

前記外側フレームと前記超音波センサの支持筒部の外周面との間に介設されるとともに前記フレームに支承されつつ前記支持筒部を支承し、かつ、前記支持筒部の振動エネルギーを減衰させる介設部材を備え、

前記介設部材は、前記振動板の周縁に近接して前記支持筒部に密着する部分は、他の部分よりも前記支持筒部を弱く拘束することを特徴とする超音波センサ。

【請求項５】請求項４記載の超音波センサにおいて、

前記介設部材は、前記振動板の周縁の所定の一部に近接して前記支持筒部を弱く拘束する低拘束領域と、前記振動板の周縁の残部に近接して前記支持筒部を強く拘束する高拘束領域とを有することを特徴とする超音波センサ。

【請求項６】請求項５記載の超音波センサにおいて、

車両の側面に固定されて前記車両から水平方向に対して

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上下所定の広がり角度を有して超音波を放射することにより障害物による反射波を検出する車両用障害物センサに用いられ、

前記介設部材の前記低拘束領域は、前記振動板の下縁部に隣接する前記支持筒部の下部に隣接して配置されることを特徴とする超音波センサ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、超音波センサに関し、好適には車両用障害物検出センサに適用可能な超音波センサに関する。

【０００２】

【従来の技術】従来の車両用障害物検出装置では、車両のバンパーに設けた超音波センサにより車両後方あるいはコーナーから超音波を送信し、障害物にて反射した超音波を受信してその障害物を検出するようにしている。

【０００３】図　に、従来の車両用障害物検出装置として用いる超音波センサの一例を示す。

【０００４】１はＰＺＴなどを素材とする磁器圧電板の両主面にそれぞれ電極を設けてなる超音波振動子、２は超音波振動子１が固定される筒状ケース、３は鍔付き円筒形状の外側フレーム、４０は外側フレーム３と筒状ケース２との間に設けられた介設部材であり、外側フレーム3は図示しないバンパーの穴に嵌合している。

【０００５】筒状ケース２は有底円筒形状の金属缶からなり、この筒状ケース２の底面部２１が振動板として超音波を放射し、反射波を検出する。筒状ケース２の底面部すなわち振動板２１の裏側中央には超音波振動子１が固定され、超音波振動子１の両電極間に交流電圧を印加して振動板２１を振動させる。

【０００６】筒状ケース２の筒部（支持筒部ともいう）２２は、両端開口円筒形状の制振用ゴム体からなる介設部材４０を介して外側フレーム３により支承されている。すなわち、この振動板２１は、その筒部（支持筒部）２２に隣接する振動板２１の周縁を節とし、振動板２１の径方向中心を腹として振動し、介設部材４０は、振動板２１の振動が外側フレーム３を通じて外部のバンパーに伝達されるのを抑止する。

【０００７】

【発明が解決しようとする課題】上記超音波センサでは、上下方向の指向特性すなわち放射広がり角度が広いと路面凹凸による反射波により障害物からの反射波と誤検出する不具合があるため、上下方向特に下側への指向特性すなわち放射広がり角度を狭くする必要があった。指向特性すなわち放射広がり角度は周波数を高めることにより狭くすることができるが、周波数選択には他の条件とのからみで自由ではなく、指向特性すなわち放射広がり角度の狭化を周波数を変えずに実現したいという要望があった。

【０００８】本発明は上記問題点に鑑みなされたもので

あり、簡素な構成で指向特性すなわち放射広がり角度を狭化可能な超音波センサを提供することをその目的としている。

【０００９】また、上述した従来の車両用障害物検出装置として用いる超音波センサでは、軸方向（振動方向）に対して左右上下の指向特性すなわち放射広がり角度の設定が重要であり、特に路面凹凸による反射波を低減するために、下方への指向特性すなわち放射広がり角度を小さくすることが望まれていた。

【００１０】この問題を解決するには、軸方向（振動方向）を水平方向より必要な角度だけ上向きに回動させてもよいが、このようにすると、超音波センサの超音波放射面をなす振動板２１がバンパー１の外表面から外側に突出又は奥側に窪んで美観を損なうという問題があった。

【００１１】本発明は上記問題点に鑑みなされたものであり、簡素な構成で、振動板の主面と直交する軸方向（振動方向）に対する指向特性すなわち放射広がり角度が振動板の周方向所定部位においてのみ選択的に狭くすることができる超音波センサを提供することを、その目的としている。

【００１２】

【問題を解決するための手段】上記目的を達成する請求項１記載の超音波センサでは、底面部が振動板をなして超音波振動子が固定される筒状ケースの筒部（支持筒部）の外周面は、支持用の外側フレームの内周面に振動エネルギー吸収機能を有する介設部材を通じて支持される。本構成では特に、介設部材が、振動板の周縁に近接して筒状ケースの支持筒部に密着しない溝部を有する。この介設部材の溝部は、振動板の全周にわたって設けてもよく、周方向の所定角度範囲だけ設けてもよい。

【００１３】実験によれば、介設部材の溝部を振動板の全周にわたって設ける場合にはセンサから放射される超音波エネルギーの指向特性すなわち放射広がり角度を狭くすることができることがわかった。

【００１４】請求項２記載の構成は、請求項１記載の超音波センサにおいて更に、溝部は振動板の周縁の所定角度範囲の部分に近接する部位においてのみ設けられる。実験によれば、このようにすることにより溝部を有する側への指向特性すなわち放射広がり角度を狭くできることがわかった。

【００１５】請求項３記載の構成によれば請求項２記載の超音波センサにおいて更に、この超音波センサは車両用の障害物センサとして用いられ、介設部材の溝部は、振動板の下縁部に隣接する支持筒部の下部に隣接して配置される。

【００１６】上記目的を達成する請求項４記載の超音波センサによれば、底面部が振動板をなして超音波振動子が固定される筒状ケースの筒部（支持筒部）と、外部フレームとの間に介設した介設部材のうち、振動板の周縁に近接して支持筒部に密着する部分は、他の部位よりも前記支持筒部を弱く拘束する低拘束領域であることを特徴としている。この低拘束領域は振動板の全周にわたって設けてもよく、所定の角度にわたって設けてもよい。

【００１７】実験によれば、介設部材の低拘束領域を振動板の全周にわたって設ける場合にはセンサから放射される超音波エネルギーの指向特性すなわち放射広がり角度を狭くすることができ、また、介設部材の低拘束領域を振動板の周方向の所定角度範囲だけ設ける場合にはセンサから放射される超音波エネルギーの指向特性すなわち放射広がり角度を低拘束領域を設けたサイドにおいて狭くすることができることがわかった。

【００１８】請求項５記載の構成によれば請求項４記載の超音波センサにおいて更に、この超音波センサは車両用の障害物センサとして用いられ、介設部材の低拘束領域は、振動板の下縁部に隣接する支持筒部の下部に隣接して配置される。

【００１９】

【発明の実施の形態】以下、本発明を図に示す実施形態について説明する。

【００２０】車両用障害物検出装置のセンサ部として用いた本発明の超音波センサの一実施形態を図１に示す模式縦断面図を参照して以下に説明する。

【００２１】１はＰＺＴなどを素材とする磁器圧電板の両主面にそれぞれ電極を設けてなる超音波振動子、２は超音波振動子１が固定される筒状ケース、３は鍔付き円筒形状の外側フレーム、４は外側フレーム３と筒状ケース２との間に設けられた介設部材であり、外側フレーム３の筒部３０は図示しないバンパーの穴に嵌合している。

【００２２】筒状ケース２は有底円筒形状の金属缶からなり、この筒状ケース２の底面部２１が振動板として超音波を放射し、反射波を検出する。筒状ケース２の底面部すなわち振動板２１の裏側中央には超音波振動子１が固定され、超音波振動子１の両電極間に交流電圧を印加して振動板２１を振動させる。

【００２３】筒状ケース２の筒部（支持筒部ともいう）２２は、両端開口円筒形状の制振用ゴム体からなる介設部材４を介して外側フレーム３により支承されている。すなわち、この振動板２１は、その筒部（支持筒部）２２に隣接する振動板２１の周縁を節とし、振動板２１の径方向中心を腹として振動し、振動板２１の振動は筒状ケース２の支持筒部２２の振動を派生させ、この支持筒部２２の振動は介設部材４及び外側フレーム３の筒部３０を通じて外部の図示しないバンパーに伝達される。

【００２４】この実施例の特徴点をなす介設部材４は、筒状ケース２の支持筒部２２と外側フレーム３の筒部３０の内周面との間の円筒状のギャップに合わせて厚さ一定の円筒形状に形成され、介設部材４の内周面は支持筒部２２の外周面に密着し、介設部材４の外周面は外側フ

レーム３の内周面に密着している。これにより、超音波振動子１の屈曲振動により筒状ケース２の振動板２１が振動し、それにより筒状ケース２の支持筒部２２が付随して振動しても、支持筒部２２の振動エネルギーは介設部材４により減衰され、外側フレーム３の筒部の振動が抑止される。超音波振動子１を長方形に形成することにより振動板２１の振動方向に対する指向特性を左右方向において広く、上下方向において狭く設定しているのは従来通りである。筒状ケース２の底面部すなわち振動板２１の外側の主面２１１、介設部材４の外側の端面４１の上半分、及び、外側フレーム３の外側面３１は略垂直方向に延在する平坦面をなしてバンパーの美観を高めている。

【００２５】この実施例では特に、介設部材４の外側の端面４１の下側約半分（正確には１４０度の角度範囲）は、振動板２１の外側の主面２１１、及び、外側フレーム３の外側面３１より所定深さだけ凹設されており、これにより溝部４２が形成されている。

【００２６】（変形態様１）変形態様を図２に示す。

【００２７】この変形態様では、溝部４２を全周にわたって設けた。このようにすれば、振動板２１の全周にわたって溝部４２がない場合よりも全周にわたって指向特性すなわち放射広がり角度が狭くなった。

【００２８】（変形態様１）変形態様を図２に示す。

【００２９】この変形態様では、溝部４２を上側に９０度の角度範囲、下側に９０度の角度範囲で２つ設けた。このようにすれば、上側及び下側の指向特性すなわち放射広がり角度が溝部がないばあいよりも狭くなった。

【００３０】（変形態様３）変形態様を図３に示す。

【００３１】この変形態様では、実施例１において溝部４２ａは薄い端壁部（本発明で言う低拘束領域）４３及び薄い薄肉筒部（本発明で言う低拘束領域）４４に隣接しており、これにより外部からこの溝部４２ａが不可視となっている。

【００３２】このようにすれば、指向特性すなわち放射広がり角度の狭化効果は低下したが、溝部４２ａが不可視となるので、美観が向上した。

【００３３】（変形態様４）変形態様を図４に示す。

【００３４】この変形態様では、変形態様３において、支持筒部２２の外周面に密接する薄い薄肉筒部（本発明で言う低拘束領域）４４の代わりに外側フレーム３の内周面に密接する薄い薄肉筒部（本発明で言う低拘束領域）４５を設けたものである。

【００３５】なお、図１において、支持筒部２２の拘束力が弱ければ、溝部４２に軟質のパテのようなものを充填してもよい。

【００３６】（変形態様５）変形態様を図５に示す。

【００３７】この変形態様では、実施例１において、振動板２１の周縁の下側の部分から溝部４２を隠すように遮蔽鍔部（本発明で言う低拘束領域）２１ａを伸ばしたものである。ただし、振動によりこの遮蔽鍔部２１ａの下端が外側フレーム３の内周面に接触しないだけのギャップｇを確保するものとする。

【００３８】このようにすれば、簡単な構成で溝部４２を不可視化することができ、美観が向上する。

【００３９】（実験結果）以下、実験結果を説明する。実験条件は次の通りである。

【００４０】図６、図７に示す試料モデルＡは、図２に示す形状のものであり、溝部４２を振動板２１の全周に設けた構造を有する。図８、図９に示す試料モデルＢは試料モデルＡにおいて溝部４２を上下にだけ設けたものである。図１０、図１１に示す試料モデルＣは、試料モデルＢにおいて溝部４２を下側にだけ設けたものである。図１２、図１３に示す試料モデルＤは、試料モデルＢにおいて溝部４２の径方向幅を約半分とし、溝部４２を振動板２１側に隣接して設けたものである。図１４、図１５に示す試料モデルＥは、振動板２１の外側の主面２１１を外側フレーム３の外側面３１よりも軸方向に距離Ｊだけ凹ませたものである。

【００４１】有底筒形状の筒状ケース２はアルミニウムを素材として形成され、内部に略直方体形状の凹部を有しており、その外周面の半径は８ｍｍ、この凹部に面する筒状ケース２の底部すなわち振動板２１の厚さは約０．７ｍｍ、支持筒部２２の長さは９ｍｍである。

【００４２】超音波振動子１は、筒状ケース２の底部すなわち振動板２１の中央裏側に固定されており、その発振周波数は４０ｋＨｚである。外側フレーム３の筒部３０の内径は１９ｍｍ、したがって介設部材４の厚さは１．５ｍｍである。介設部材４としてはシリコンゴムを用いた。これら各試料モデルで種々寸法を変えた場合の指向特性を図１６～図２９に示す。なお、図１６～図２９において広、狭二つの指向特性のうち、広い指向特性の方は左右方向の指向特性を示し、狭い方は上下方向の指向特性を示す。これらの指向特性の差は、上述した振動板２１が垂直方向に長い長方形状により生じる。指向特性は、振動板２１から３０ｃｍ離れた位置に垂直方向にポールを立て、振動板２１すなわちセンサをまず左右に回動させて水平方向の指向特性を調べ、次に上下に回動させて垂直方向の指向特性を調べた。もちろん、振動子１の発振時間はポールからの反射波が振動子１に入射するまでに終了するようにした。

【００４３】図１６は、図７（試料モデルＡ）に示す溝部４２の深さＡを０ｍｍとした場合の指向特性を示す。

【００４４】図１７は、図７に示す溝部４２の深さを１ｍｍとした場合の指向特性を示す。

【００４５】図１８は、図７に示す溝部４２の深さを２ｍｍとした場合の指向特性を示す。

【００４６】図１６と図１７との比較から、試料モデルＡにおいては、溝部４２を設けることにより指向特性が向上することがわかる。また、図１７と図１８との比較

から、わずかであるが、溝部４２が深すぎるとかえって指向特性が悪化することがわかる。

【００４７】図１９は、図９（試料モデルＢ）に示す溝部４２の左右幅Ｂを８ｍｍ、深さＣを１．５ｍｍとした場合の指向特性を示す。

【００４８】図２０は、図９に示す溝部４２の左右幅Ｂを１０ｍｍ、深さＣを１ｍｍとした場合の指向特性を示す。

【００４９】図２１は、図９に示す溝部４２の左右幅Ｂを１０ｍｍ、深さＣを１．５ｍｍとした場合の指向特性を示す。

【００５０】図２２は、図９に示す溝部４２の左右幅Ｂを１０ｍｍ、深さＣを２．０ｍｍとした場合の指向特性を示す。

【００５１】これら図１７～図２２によれば、すべて、図１６に示す溝なし型に比較して指向特性が鋭くなっていることがわかる。

【００５２】図２３は、図１１（試料モデルＣ）に示す溝部４２の左右幅Ｄを１０ｍｍ、深さＥを１ｍｍとした場合の指向特性を示す。

【００５３】図２４は、図１１に示す溝部４２の左右幅Ｄを１０ｍｍ、深さＥを３ｍｍとした場合の指向特性を示す。

【００５４】図２３によれば、上下に溝部４２を設ける図２０に比較して、上側の指向特性だけが広がっていることがわかる。図２３と図２４との比較から、溝部４２の深さが深い場合のほうが下側の指向特性がわずかに広がり、上側の指向特性が狭くなっていることがわかる。

【００５５】図２５は、図１３（試料モデルＤ）に示す溝部４２の左右幅Ｆを１０ｍｍ、深さＧを１．５ｍｍとした場合の指向特性を示す。図２５から、溝部４２の径方向幅を狭化することにより上下方向の指向特性が特に狭くなっていることがわかる。

【００５６】図２６は、図１５（試料モデルＥ）に示す溝部４２の左右幅Ｈを１０ｍｍ、振動板２１の窪み距離Ｉを１．５ｍｍ、溝部４２の軸方向深さＪを０．５ｍｍとした場合の指向特性を示す。

【００５７】図２７は、図１５に示す溝部４２の左右幅Ｈを１０ｍｍ、振動板２１の窪み距離Ｉを２ｍｍ、溝部４２の軸方向深さＪを０．５ｍｍとした場合の指向特性を示す。

【００５８】図２８は、図１５に示す溝部４２の左右幅Ｈを１０ｍｍ、振動板２１の窪み距離Ｉを２．５ｍｍ、溝部４２の軸方向深さＪを０．５ｍｍとした場合の指向特性を示す。

【００５９】図２９は、図１５に示す溝部４２の左右幅Ｈを１０ｍｍ、振動板２１の窪み距離Ｉを３．０ｍｍ、溝部４２の軸方向深さＪを０．５ｍｍとした場合の指向特性を示す。

【００６０】図２６と図２１との比較から、窪み距離Ｉを設けることにより振動板２１を窪ませない場合より指向特性をシャープにできることがわかる。また、図２６と図２７～図２９とを比較することにより、窪み距離Ｉを大きくし過ぎるとかえって指向特性は広くなってしまうことがわかる。

【図面の簡単な説明】

【図１】　本発明の超音波センサの実施例を示す縦断面図である。

【図２】　本発明の超音波センサの変形態様を示す縦断面図である。

【図３】　本発明の超音波センサの変形態様を示す縦断面図である。

【図４】　本発明の超音波センサの変形態様を示す縦断面図である。

【図５】　本発明の超音波センサの変形態様を示す縦断面図である。

【図６】　試料モデルＡの模式正面図である。

【図７】　試料モデルＡの模式軸方向断面図である。

【図８】　試料モデルＢの模式正面図である。

【図９】　試料モデルＢの模式軸方向断面図である。

【図１０】試料モデルＣの模式正面図である。

【図１１】試料モデルＣの模式軸方向断面図である。

【図１２】試料モデルＤの模式正面図である。

【図１３】試料モデルＤの模式軸方向断面図である。

【図１４】試料モデルＥの模式正面図である。

【図１５】試料モデルＥの模式軸方向断面図である。

【図１６】試料モデルＡの指向特性を示す図である。

【図１７】試料モデルＡの指向特性を示す図である。

【図１８】試料モデルＡの指向特性を示す図である。

【図１９】試料モデルＢの指向特性を示す図である。

【図２０】試料モデルＢの指向特性を示す図である。

【図２１】試料モデルＢの指向特性を示す図である。

【図２２】試料モデルＢの指向特性を示す図である。

【図２３】試料モデルＣの指向特性を示す図である。

【図２４】試料モデルＣの指向特性を示す図である。

【図２５】試料モデルＤの指向特性を示す図である。

【図２６】試料モデルＥの指向特性を示す図である。

【図２７】試料モデルＥの指向特性を示す図である。

【図２８】試料モデルＥの指向特性を示す図である。

【図２９】試料モデルＥの指向特性を示す図である。

【符号の説明】

１…超音波振動子

２…筒状ケース

３は外側フレーム

４は介設部材

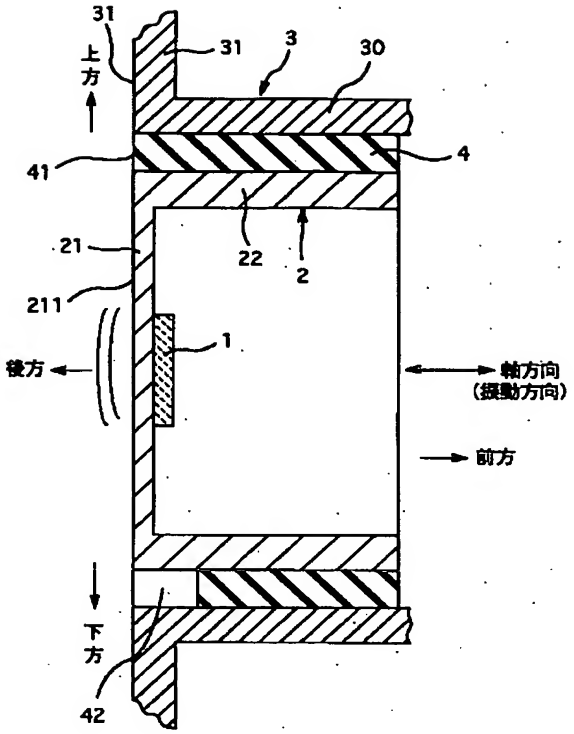
２１は振動板

４２は溝部

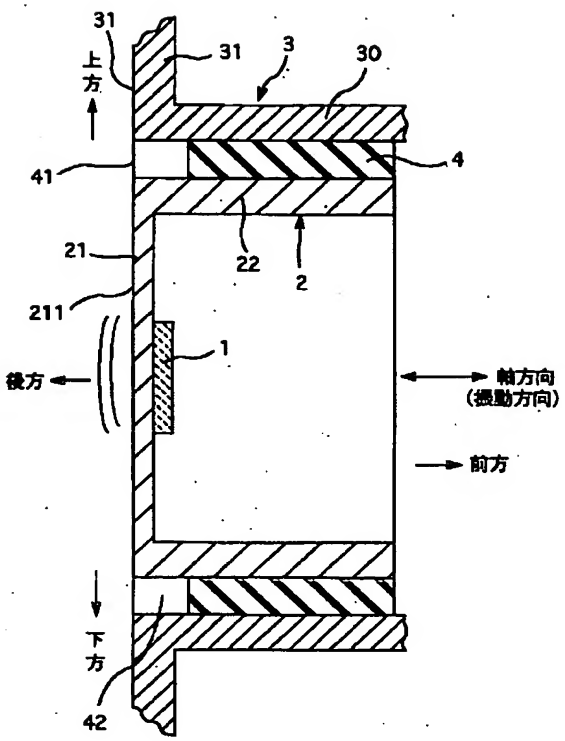
４４…薄肉筒部（本発明で言う低拘束領域）

４５…薄肉筒部（本発明で言う低拘束領域）

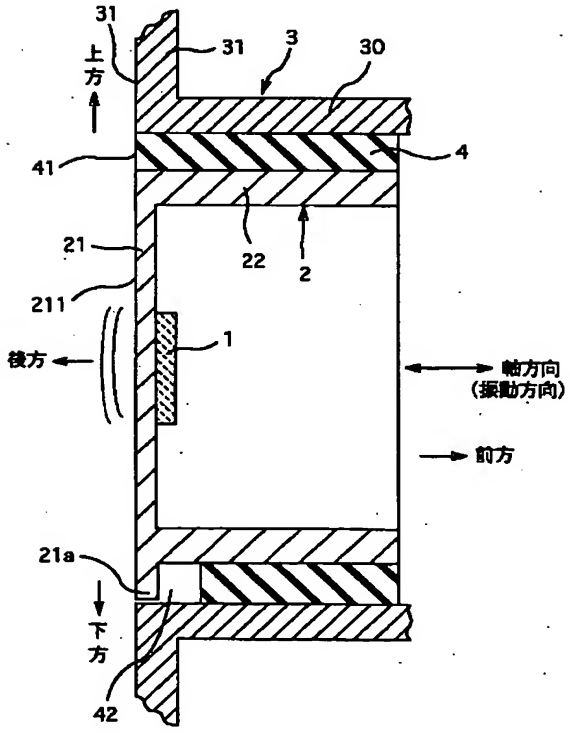
【図１】


31
上方
31
3
30
41
4
21
22
2
211
1
後方
軸方向
(振動方向)
前方
下方
42

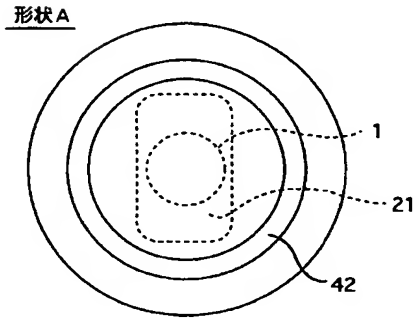
【図２】


31
上方
31
3
30
41
4
21
22
2
211
1
後方
軸方向
(振動方向)
前方
下方
42

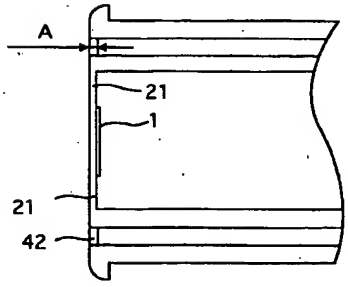
【図５】


31
上方
31
3
30
41
4
21
22
2
211
1
後方
軸方向
(振動方向)
前方
21a
下方
42

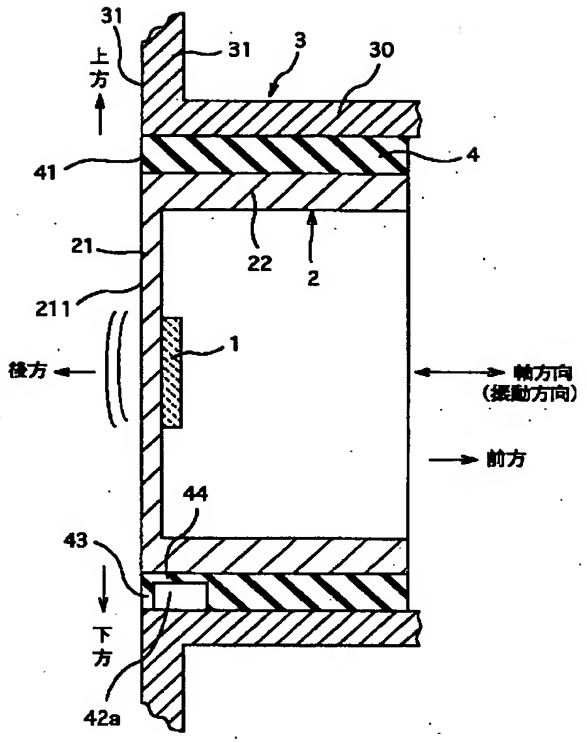
【図６】


形状A
1
21
42

【図７】


A
21
1
21
42

【図３】



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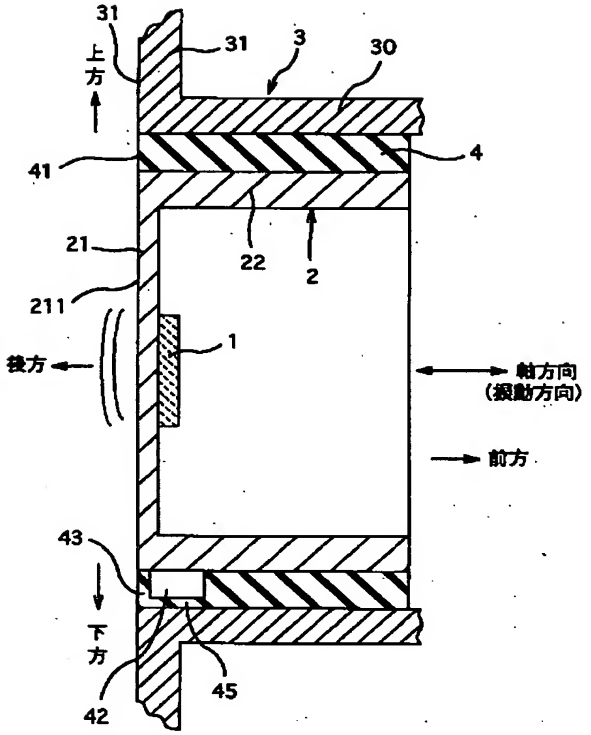

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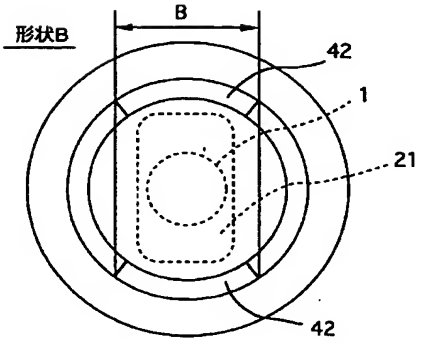

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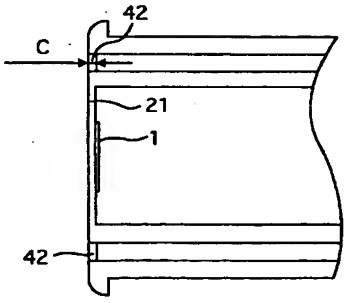

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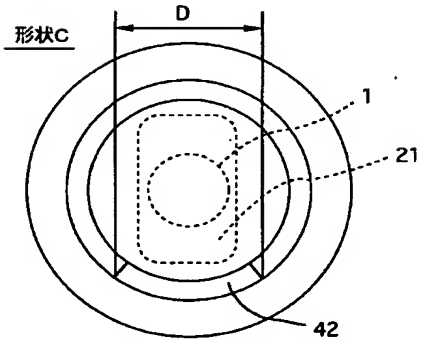
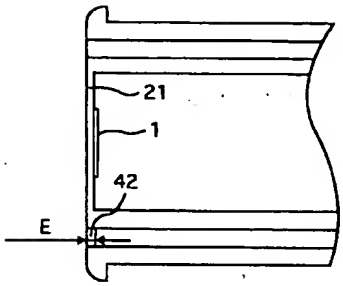
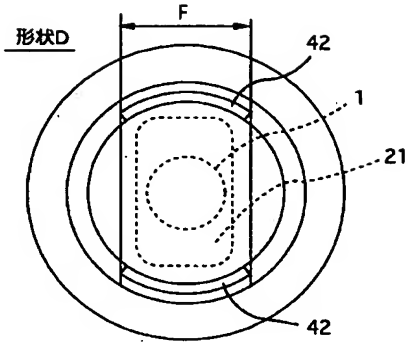


【図１１】



【図１２】



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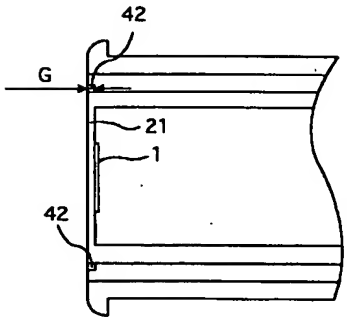

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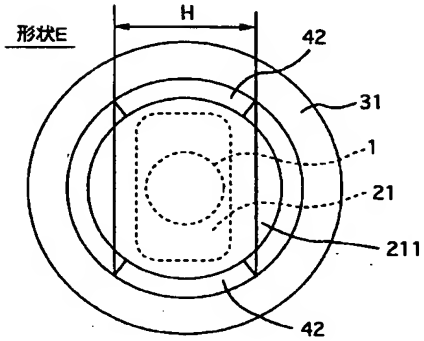

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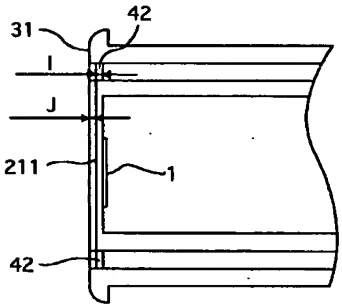

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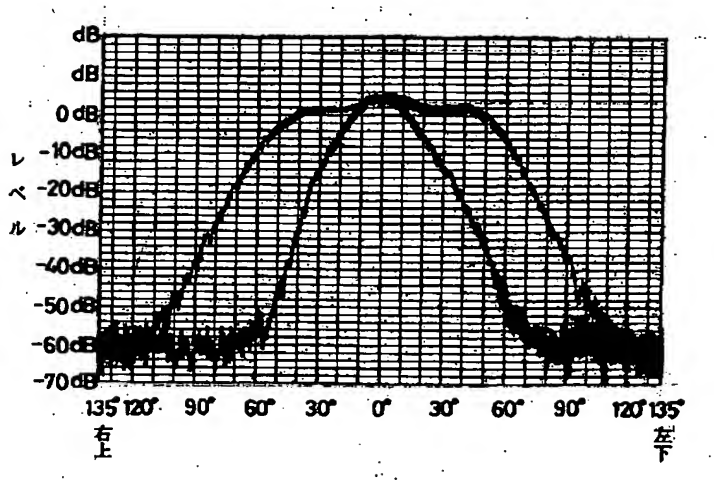

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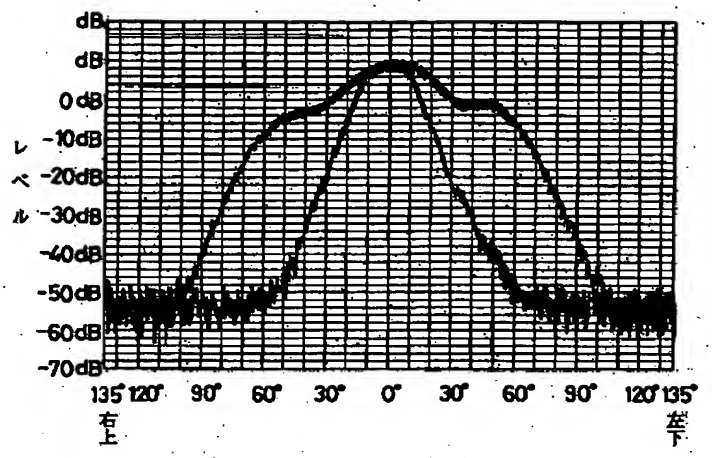
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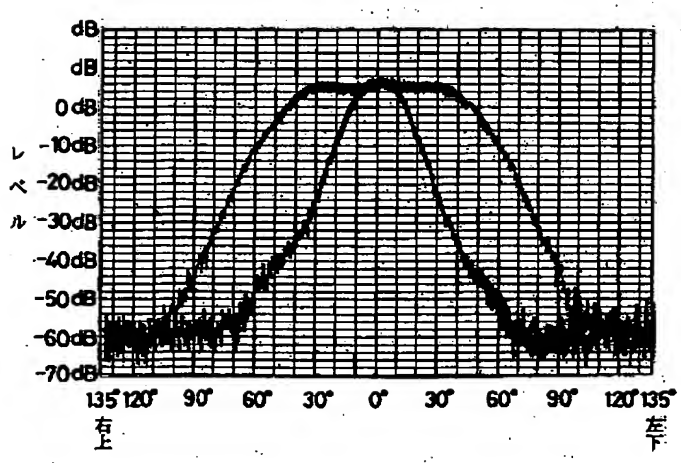
【図１８】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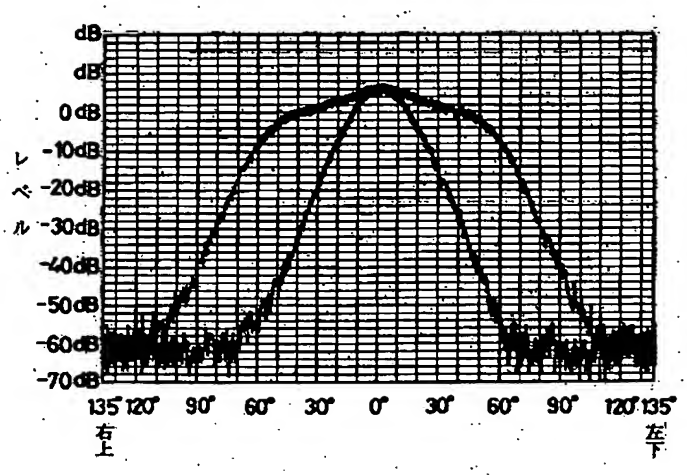
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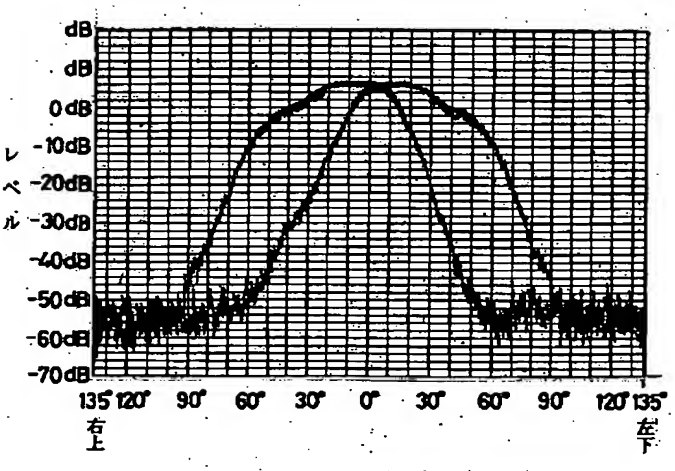
【図２０】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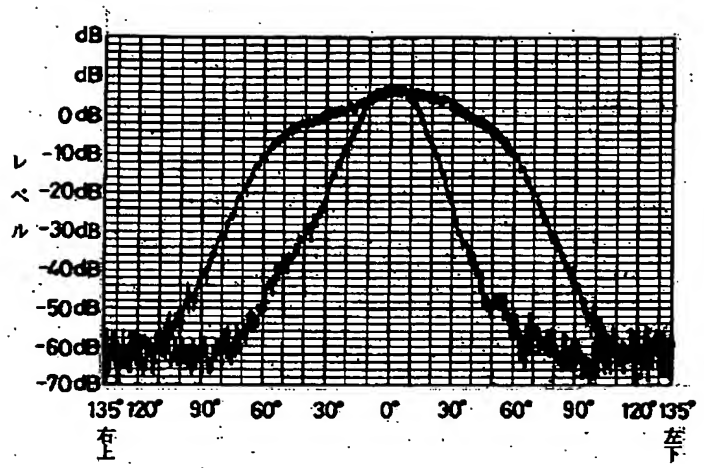
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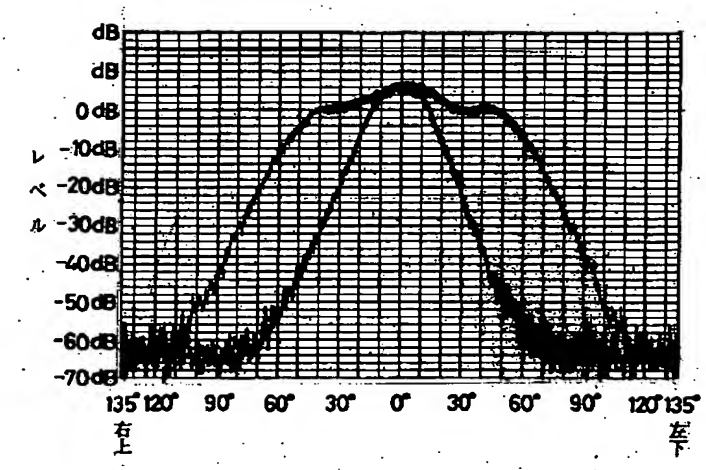
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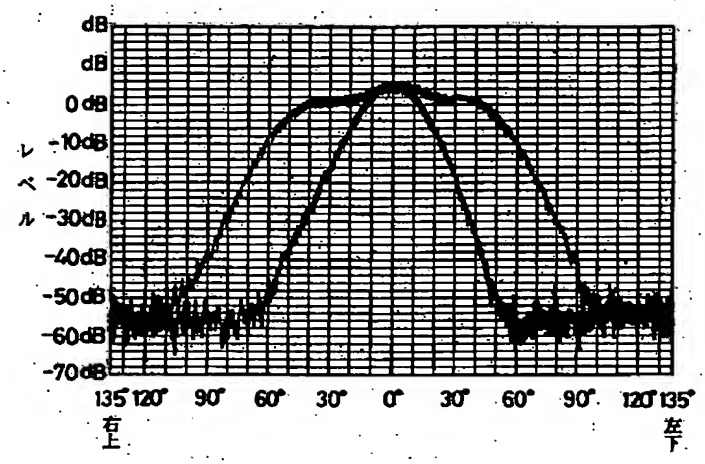
【図２３】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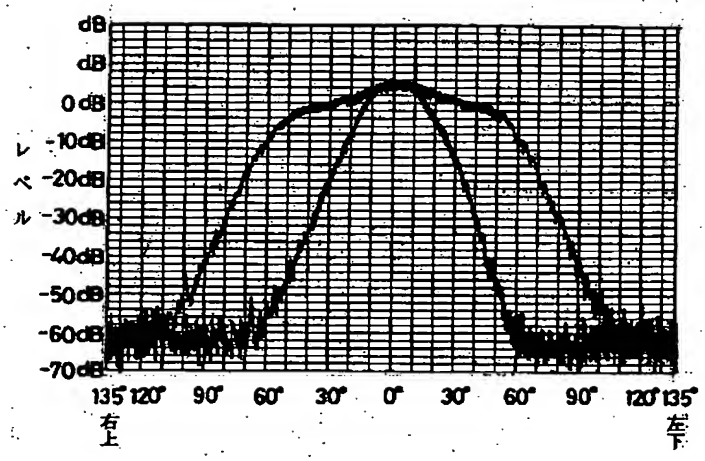
【図２４】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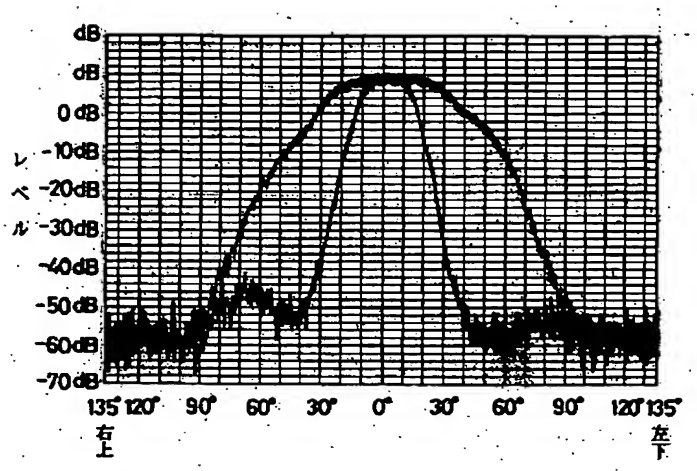
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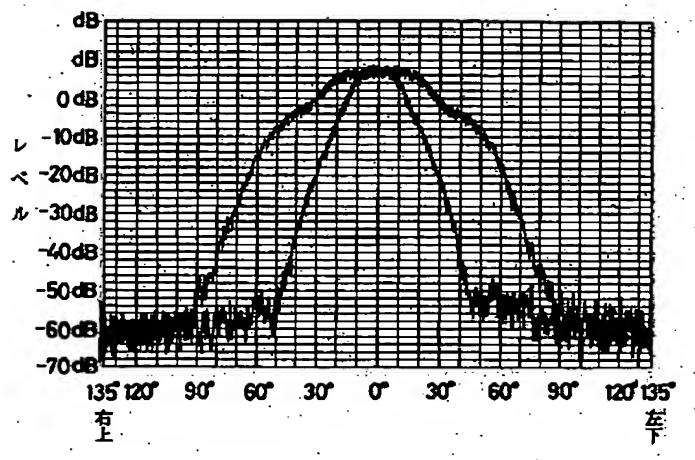
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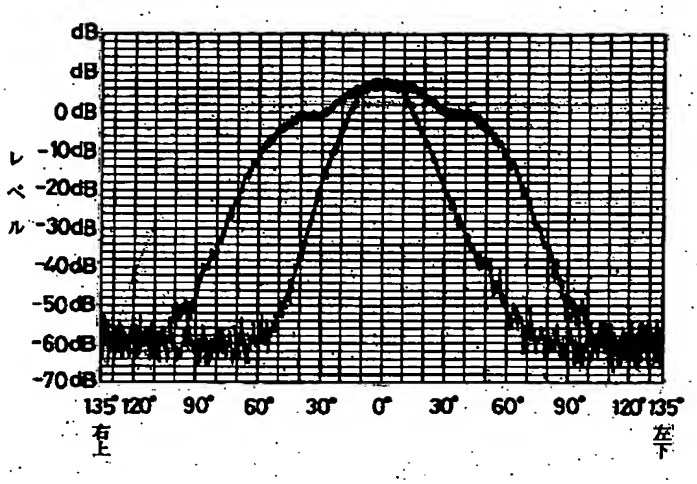
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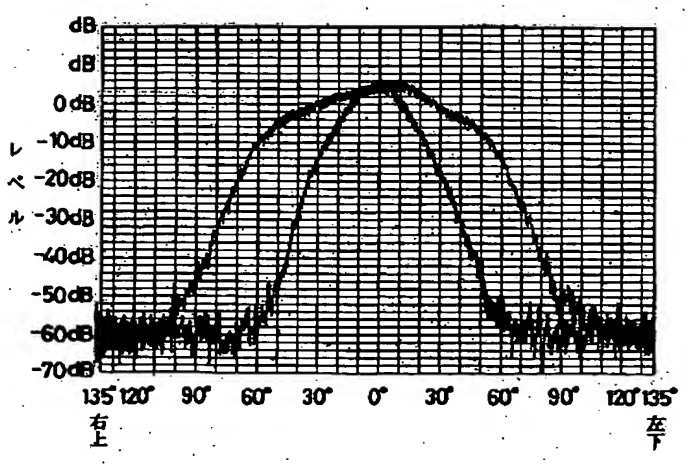
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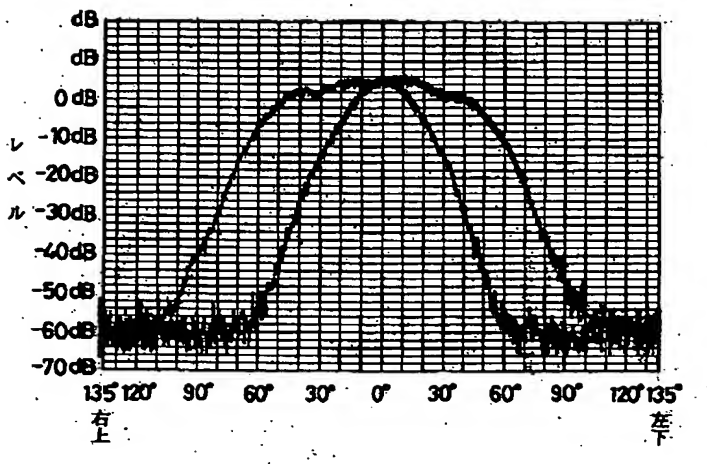
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